Eye movements and reading development

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1st grade, fall
1st grade, fall
Skilled adult
Reading research in general

• Research has concentrated on large languages
  • English as the model language despite its peculiarities
• Research of children’s eye movements gotten ground only recently
Cultural differences

• Depth of orthography
  • Finnish vs. English
Depth of orthography

• In Finnish it’s easy to read novel words
  • E.g. ”morkki”
  • Rhymes with ”korkki” for sure

• Not so much in English
  • Esim. ”brough”
  • Rhymes with ”trough”, ”rough”, ”through”, something else?
Cultural differences

• Depth of orthography
• Reading direction
• Writing system
  • Alphabetic vs. logographic

Reading in general
(Blythe & Joseph, 2011)

- Fixations
  - For adults approx. 200-250 ms
  - For 7-year-old children approx. 280-350 ms
Reading in general
(Blythe & Joseph, 2011)

• Fixations
  • For adults approx. 200-250 ms
  • For 7-year-old children approx. 280-350 ms

• Saccades
  • For adults approx. 7-8 letters
  • For 8-year-old children approx. 3-5 letters
Reading in general
(Blythe & Joseph, 2011)

- Regressions
  - For adults approx. 20% of saccades
  - For 7-year-olds approx. 30% of saccades
Reading in general
(Blythe & Joseph, 2011)

• Regressions
  • For adults approx. 20% of saccades
  • For 7-year-olds approx. 30% of saccades

• Skips
  • For adults approx. 15-20% of words
  • For 8-year-olds approx. 5-10% of words
Reading in general
(Blythe & Joseph, 2011)

• Fixations
• Saccades
• Regressions
• Skips
• Approaching adult level around 11 years of age
Optimal viewing position

- Word recognition fastest a little bit left of the word center (e.g., Vitu et al., 2001)
- Also for 7-11-year-old children (Joseph et al., 2009)
Word properties
(Rayner, 1998)

• Length

KATU vs. KAPTEENI
Word properties
(Rayner, 1998)

- Length
- Frequency
  - Note: frequency may vary between individuals and groups!
Word properties
(Rayner, 1998)

- Length
- Frequency
- Age of acquisition

SAMMAKKO vs. ANKERIAS
Word properties
(Rayner, 1998)

- Length
- Frequency
- Age of acquisition
- Letter frequency

OTSA vs. PÖLY
Word properties
(Rayner, 1998)

- Length
- Frequency
- Age of acquisition
- Letter frequency
- Context

Tämä iloinen tyttö vs. Tämä iloinen hattu
Word properties
(Rayner, 1998)

- Length
- Frequency
- Age of acquisition
- Letter frequency
- Context
- Affects both adults and children, as early as 7-year-olds for many properties (Blythe & Joseph, 2011)
- Word recognition slower for children despite this!
Text and reader properties

• Text difficulty (e.g., Rayner, 1986)
• Reader perspective (e.g. Kaakinen & Hyönä, 2010)
• Reader strategies (e.g., Hyönä et al., 2002)
Area of effective vision

- Is speedreading possible?
- The area of sharp vision quite narrow
- Saccadic programming

...p vision is narrower than we act...
Area of effective vision

• Is speedreading possible?
• The area of sharp vision quite narrow
• Saccadic programming
• Two schools
  • Attention in one vs. several words at the same time (e.g. Reichle et al., 2006 vs. Engbert et al., 2005)
  • Seriality of text
Text change paradigms

- Changes to the text during reading
- Saccadic suppression
Moving window paradigm
(McConkie & Rayner, 1975)

Mbou jou read text through e wculry mlubcm,
jcn oem’f aoo fka mbcia fazf ef cuoa. Tuefasb,
gcn noaf wcuo gcon sgsa eoncaa fbs fazf fc
iaenu fks asonsfa ct fba efcnq.
Moving window paradigm
(McConkie & Rayner, 1975)

Mbou jcn naeb fozf fbrough a moving windcm,

jcn oem’f aoo fka mbcia fazf ef cuoa. Tuefasb,
gcn noaf wcuo gcon sgsa eoncaaa fbs fazf fc
iaenu fks asonsfa ct fba efcng.
Moving window paradigm
(McConkie & Rayner, 1975)

Mbou jcn naeb fozf fbncoyb e wculry mlubcm,

jou can’t see the whcia fazf ef cuoa. Tuefasb,

gcn noaf wcuo gcon sgsa eonca a fbs fazf fc

iaenu fks asonsfa ct fba efcng.
Perceptual span
(Rayner, 1986; Häikiö et al. 2009)

- Studied with moving window paradigm
- When the window is smaller than the perceptual span, reading slows down
Perceptual span
(Rayner, 1986; Häikiö et al. 2009)

• Even at 7 years of age the perceptual span is asymmetric, i.e., towards upcoming text
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Perceptual span
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- Even at 7 years of age the perceptual span is asymmetric, i.e., towards upcoming text
- 6th graders extract information from as wide area as adults (14-15 characters to the right)
  - Usually from the beginning of the fixated word to the end of the upcoming word
  - Differences in reading speed, i.e., amount of practice
  - May be fully developed at 4th grade already (Häikiö et al., 2009)
Letter identity:

How wide the perceptual span is?
Letter identity:

How wide the perceptual span is?
Grade 2
Letter identity:

How **wide the** perceptual span is?

Grade 4
Letter identity:

How **wide the** perceptual span is?
Grade 6 + adults
Letter identity:

How **wide** the perceptual span is?
Grade 2

- Also more grainy information further away
How wide the perceptual span is?

Letter shapes: o and c, t and f

- Also more grainy information further away
How wide the perceptual span is?

Grade 2

• Also more grainy information further away
How wide the perceptual span is?
Grade 6 + adults

- Also more grainy information further away
Perceptual span
(Rayner, 1986; Häikiö et al. 2009)

• Children more focused on currently fixated word
  • Parafoveal processing one of the key factors on route to skilled reading (Blythe & Joseph, 2011)
• Harder text -> smaller span for every age group
What kind of information from the upcoming word?

• Short words get skipped -> word meanings can be processed while fixating the previous word
• Studied with the boundary paradigm (Rayner, 1975)
Boundary paradigm
(Rayner, 1975)

In the boundary paradigm, fibono is a change.
Boundary paradigm
(Rayner, 1975)

In the boundary paradigm, fbono is a change.
Boundary paradigm
(Rayner, 1975)

In the boundary paradigm there is a change.
Boundary paradigm
(Rayner, 1975)

In the boundary paradigm there is a change.
What kind of information from the upcoming word?

• From the upcoming word, both orthography and phonology (Häikiö et al., 2010; Tiffin-Richards & Schroeder, 2015)
  • Speeds up word recognition
  • More information from the upcoming word if spatially unified, i.e., compound (Häikiö et al., 2010)

• The role of semantics under debate for adults (e.g., Hyönä & Häikiö, 2005; Schotter et al., 2015)
Speed of information intake

• How much time is needed for visual information intake?
• Studied with disappearing text paradigm
Disappearing text paradigm
(Liversedge et al., 2004; Rayner et al., 2003)

There was a hospital at the end of the road.
Disappearing text paradigm
(Liversedge et al., 2004; Rayner et al., 2003)

was a hospital at the end of the road.
Disappearing text paradigm
(Liversedge et al., 2004; Rayner et al., 2003)

There is a hospital at the end of the road.
Disappearing text paradigm
(Liversedge et al., 2004; Rayner et al., 2003)

There was a [insert word] at the end of the road.
Disappearing text paradigm
(Liversedge et al., 2004; Rayner et al., 2003)

There was a hospital at the end of the road.
There is a hospital at the end of the road.
Speed of information intake

• 60 ms enough for 7-year-old children (Blythe et al., 2009)
  • However, problems for 8-9-year-old children with longer words (Blythe et al., 2011)
Differences in reading

• Finnish children learn to read rapidly even though they enter the school at a later age (Seymour et al., 2003)
  • In practice the same level during 1st grade as in English 3rd grade
  • The role of orthography
• Large, quite stable individual differences
Towards larger units
(e.g., Ehri, 1995; Grainger & Ziegler, 2011)

• Letter by letter
• Towards larger units such as syllables
• Finally words can be processed as wholes
Syllables

- Syllables as processing units for both adults and children (e.g., Ashby, 2010; Hautala et al., 2012; Maïonchi-Pino et al., 2010)
- Both word and syllable frequency at play
  - In frequent words syllables not necessary
  - Frequent syllables come first (e.g., sie vs. kor)
The use of syllabification
(Häikiö et al., 2015, in press)

• Hy-phen-a-tion slows down already in the fall of 1st grade
• No such slow-down for alternate coloring
• Hyphens beneficial in the very beginning?
• Hyphens beneficial in writing?
Summary

• Fast development
  • Basic skills around 7-8 years
  • After a few years the only difference to adults due to the amount of practice (reading speed)
• Fluctuation of perceptual span
• Towards larger units
Thank you!
Tools in word recognition

Source: Häikiö et al. (2015)