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Eye movements and reading development

Tuomo Häikiö, University of Turku

23.11.2015

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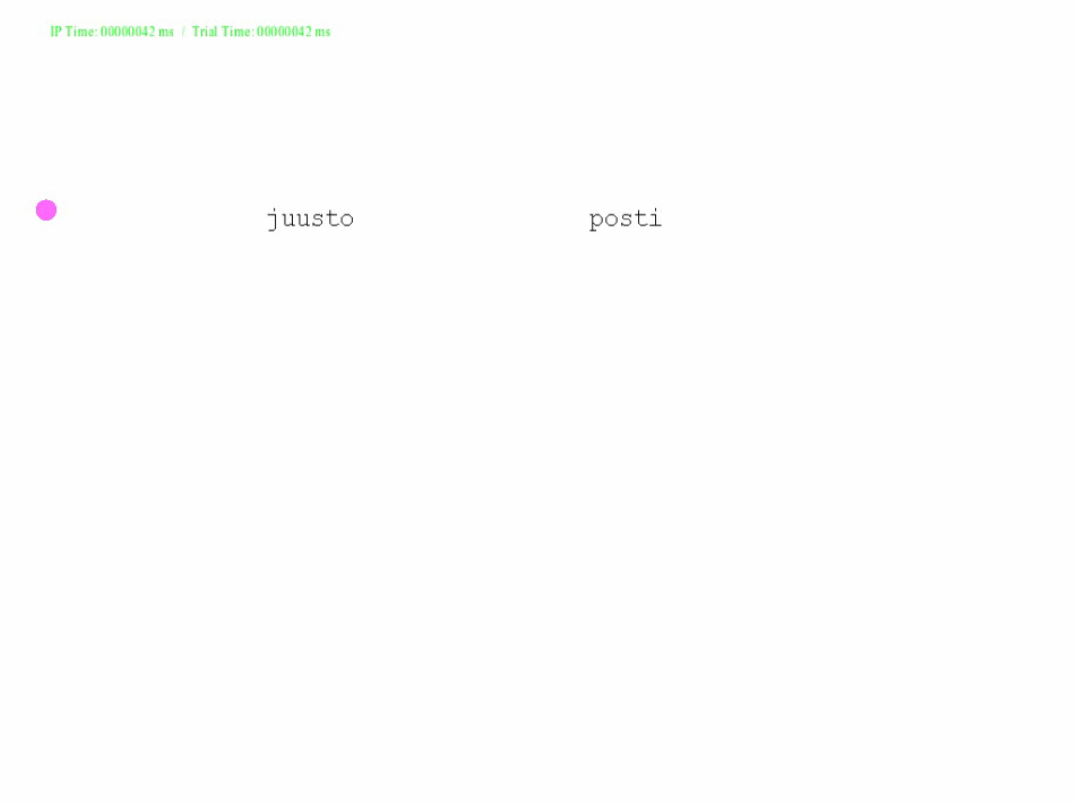
1st grade, fall



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1st grade, fall

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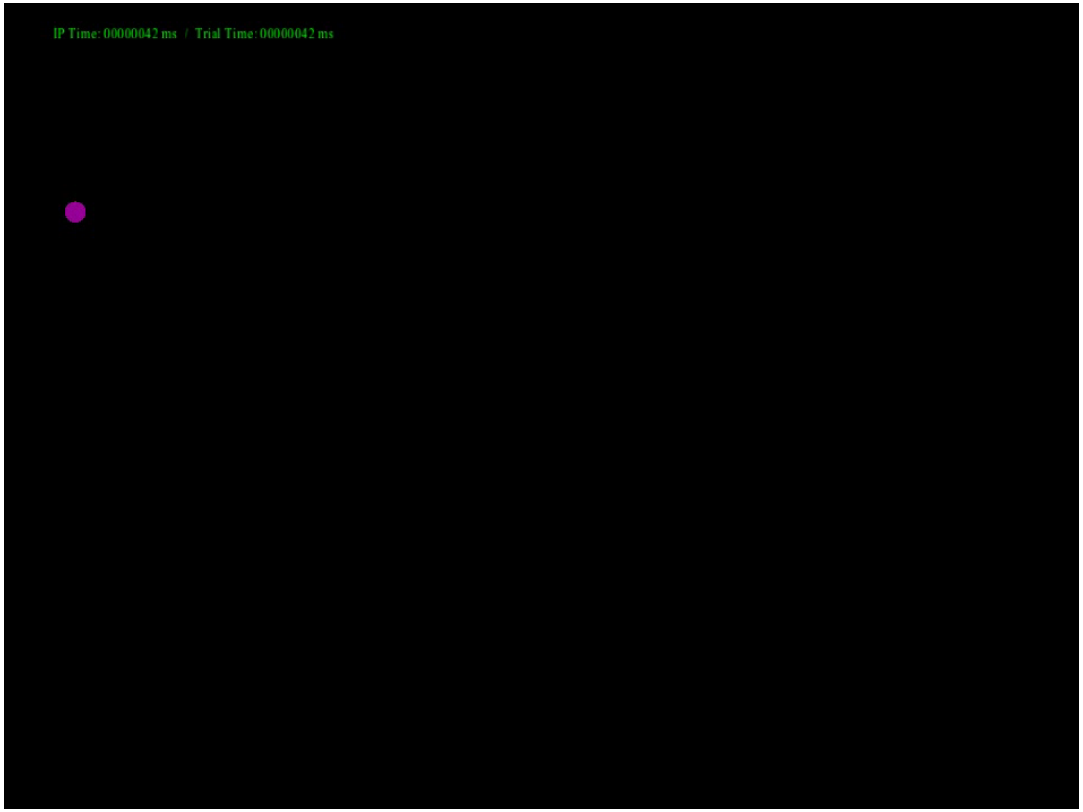
Skilled adult



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Reading research in general

- Research has concentrated on large languages
  - English as the model language despite its pecularities
- Research of children's eye movements gotten ground only recently

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Cultural differences

- Depth of orthography
  - Finnish vs. English

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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?

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Cultural differences

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

Source: http://en.wikipedia.org/wiki/Chinese_characters

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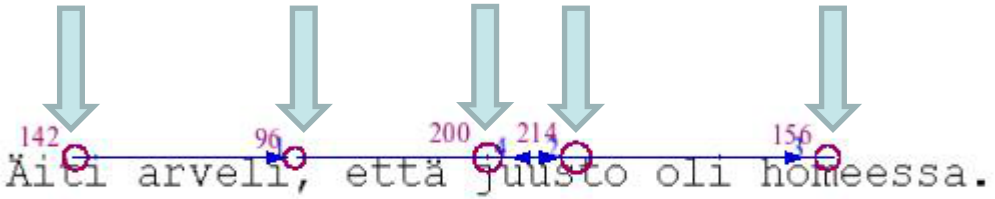
Reading in general

(Blythe & Joseph, 2011)

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



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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

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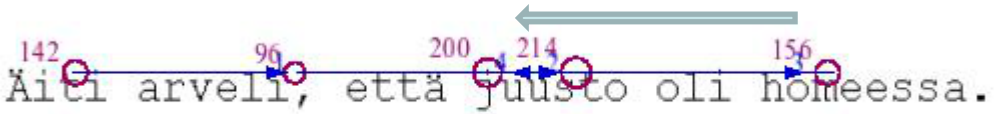
Reading in general

(Blythe & Joseph, 2011)

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



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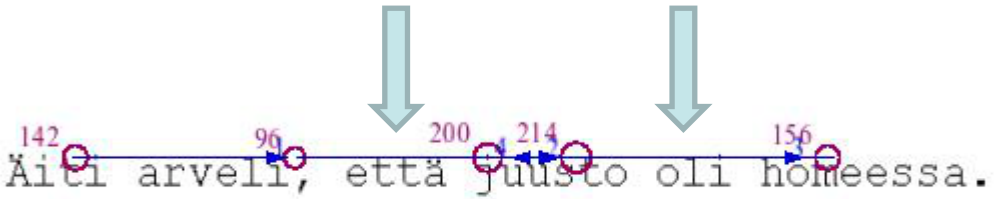
Reading in general

(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



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Reading in general

(Blythe & Joseph, 2011)

- Fixations
- Saccades
- Regressions
- Skips
- Approaching adult level around 11 years of age

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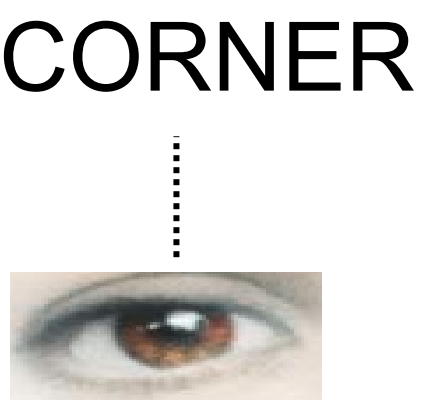
Optimal viewing position

- 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)



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Word properties

(Rayner, 1998)

- Length

KATU vs. KAPTEENI

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Word properties

(Rayner, 1998)

- Length
- Frequency
  - Note: frequency may vary between individuals and groups!

SILTA vs. SIENI

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Word properties

(Rayner, 1998)

- Length
- Frequency
- Age of acquisition

SAMMAKKO vs. ANKERIAS

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Word properties

(Rayner, 1998)

- Length
- Frequency
- Age of acquisition
- Letter frequency

OTSA vs. PÖLY

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Word properties

(Rayner, 1998)

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

Tämä iloinen tyttö vs.
Tämä iloinen hattu

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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!

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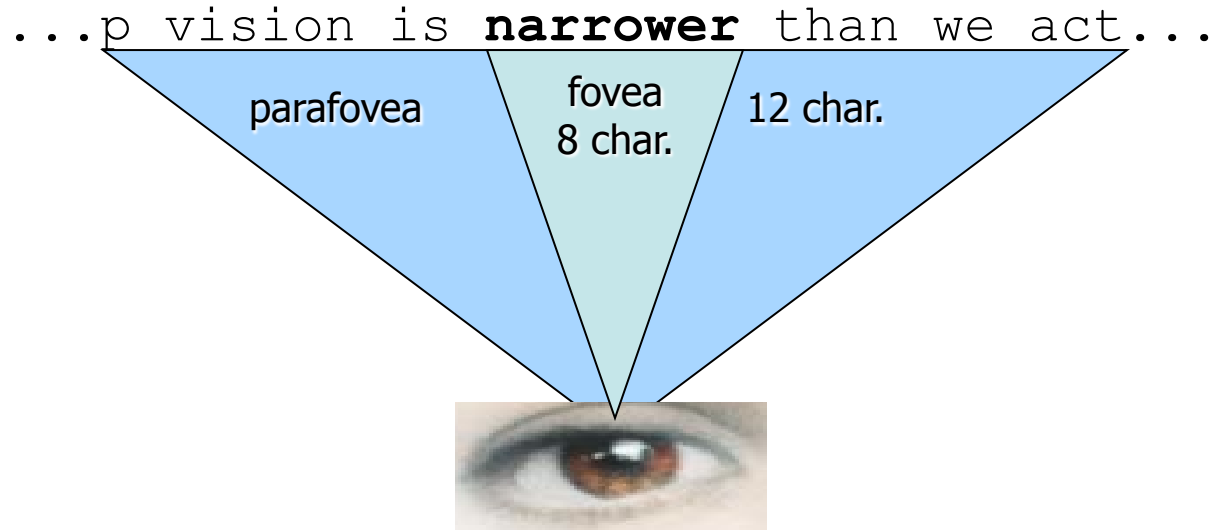
Text and reader properties

- 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



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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

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Text change paradigms

- Changes to the text during reading
- Saccadic suppression

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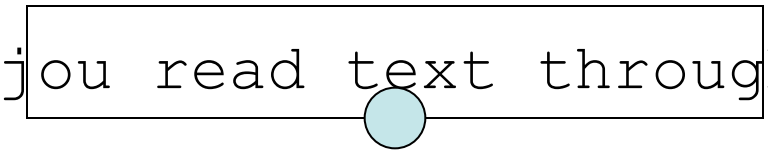
Moving window paradigm

(McConkie & Rayner, 1975)



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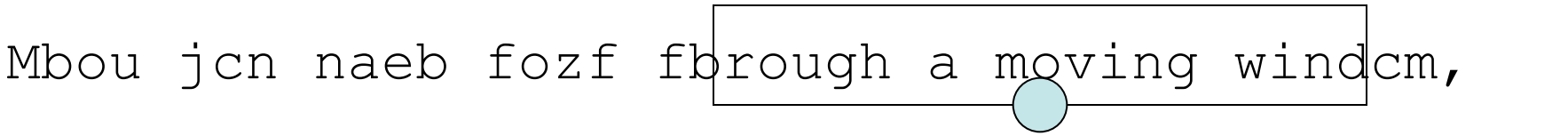
Moving window paradigm

(McConkie & Rayner, 1975)



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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 eoncaa fbs fazf fc

iaenu fks asonsfa ct fba efcng.

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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

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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

(Rayner, 1986; Häikiö et al. 2009)

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Perceptual span

(Rayner, 1986; Häikiö et al. 2009)

- 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)

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Perceptual span

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Perceptual span

(Rayner, 1986; Häikiö et al. 2009)

- 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)

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Letter identity:

How wide the perceptual span is?

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Letter identity:

How **wide t**he perceptual span is?

Grade 2

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Letter identity:

How **wide the** perceptual span is?

Grade 4

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Letter identity:

How **wide the p**erceptual span is?

Grade 6 + adults

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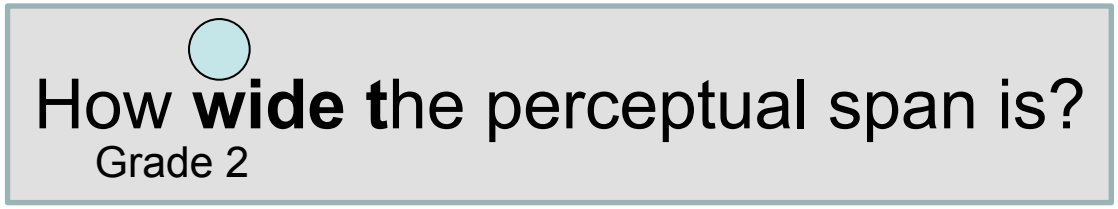
Letter identity:



- Also more grainy information further away

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o and c, t and f

Letter shapes:

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

- Also more grainy information further away

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Word length:

- Also more grainy information further away

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Word length:

- Also more grainy information further away

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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

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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)

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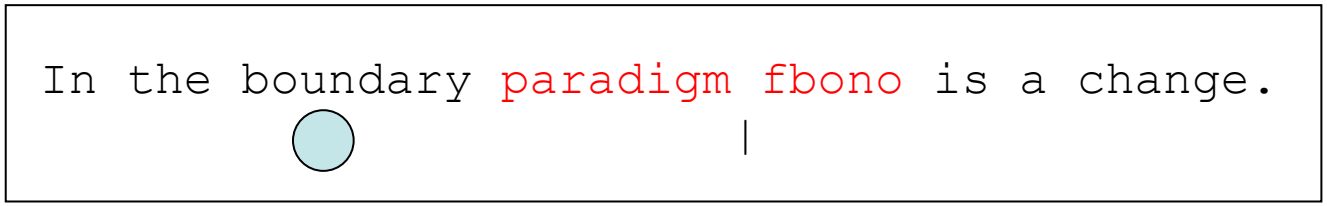
Boundary paradigm

(Rayner, 1975)



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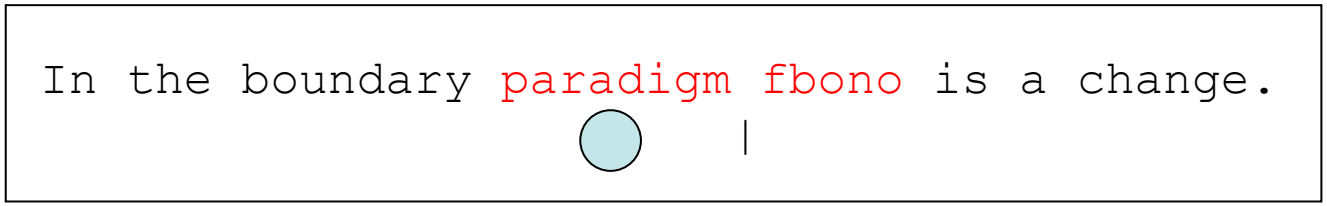
Boundary paradigm

(Rayner, 1975)



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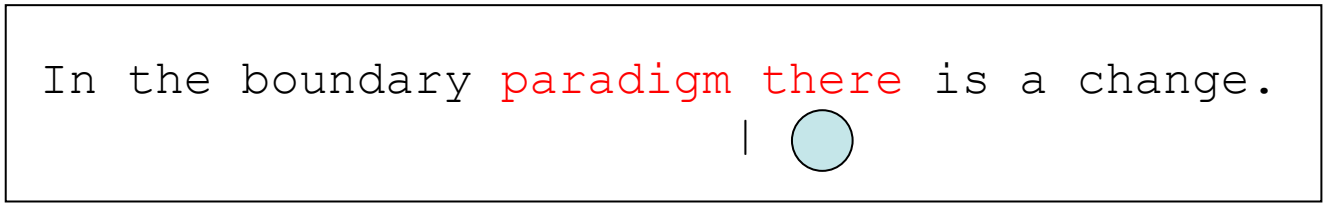
Boundary paradigm

(Rayner, 1975)



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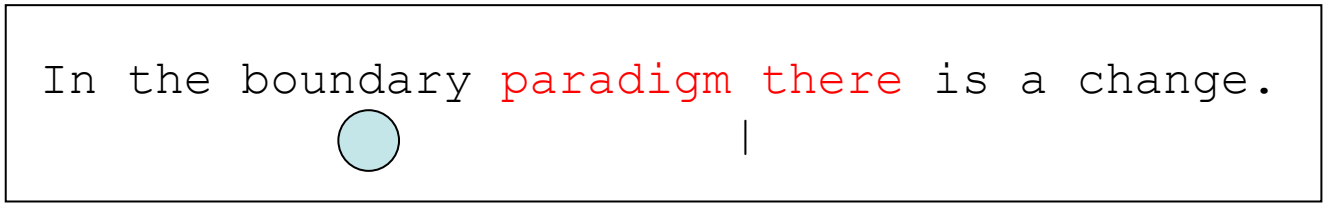
Boundary paradigm

(Rayner, 1975)



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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)

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Speed of information intake

- How much time is needed for visual information intake?
- Studied with disappearing text paradigm

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Disappearing text paradigm

(Liversedge et al., 2004; Rayner et al., 2003)

There was a hospital at the end of the road.

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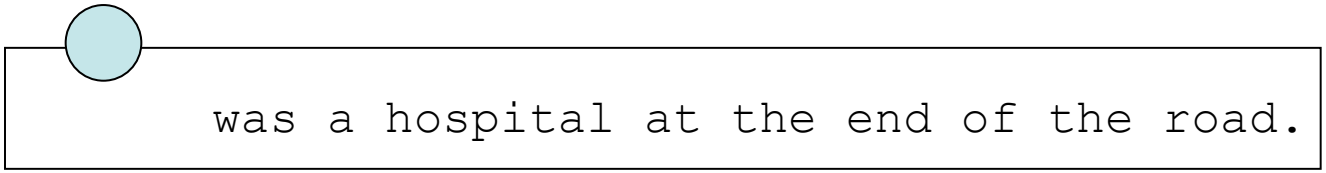
Disappearing text paradigm

(Liversedge et al., 2004; Rayner et al., 2003)



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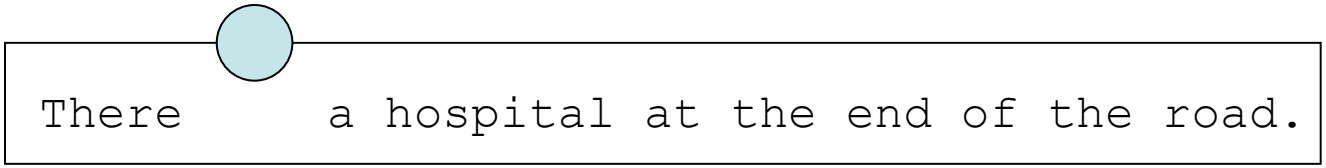
Disappearing text paradigm

(Liversedge et al., 2004; Rayner et al., 2003)



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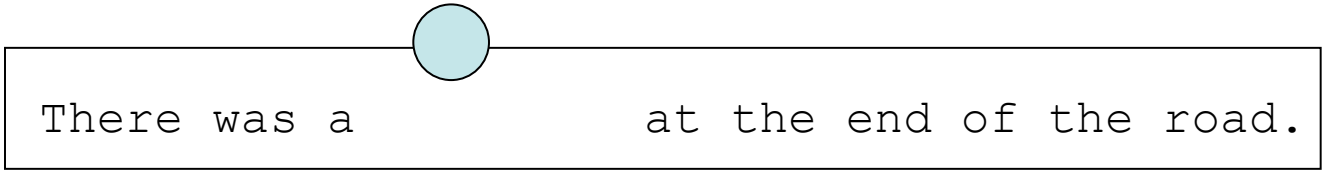
Disappearing text paradigm

(Liversedge et al., 2004; Rayner et al., 2003)



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Disappearing text paradigm

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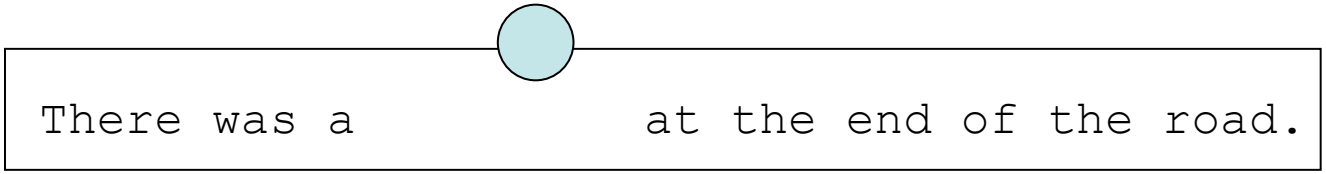

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Disappearing text paradigm

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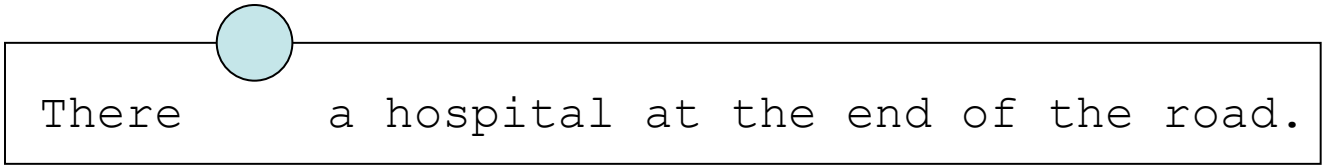

Speed of information intake

- 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)

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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

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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

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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)

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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

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Thank you!

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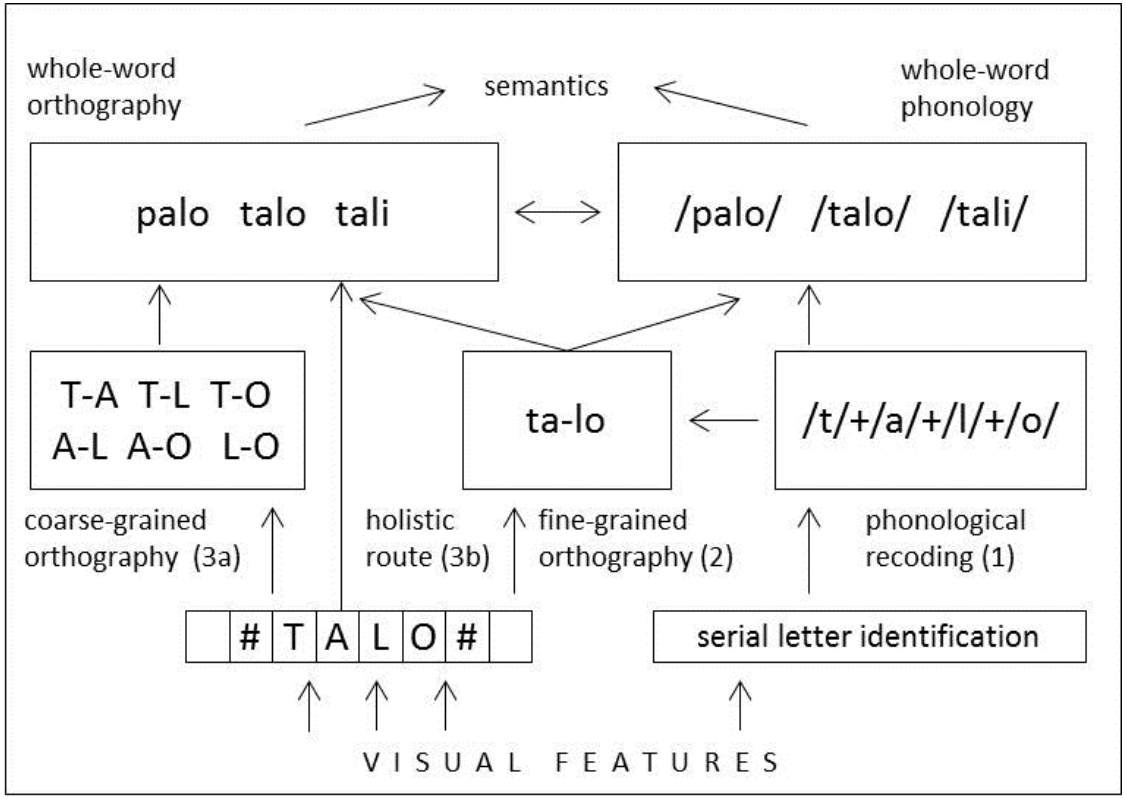
Tools in word recognition



Source: Häikiö et al. (2015)