# The effect of context on the critical print size for reading

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## Critical print size for reading

Plots of reading speed versus print size reveal two important measures of visual function (Legge, 2007):

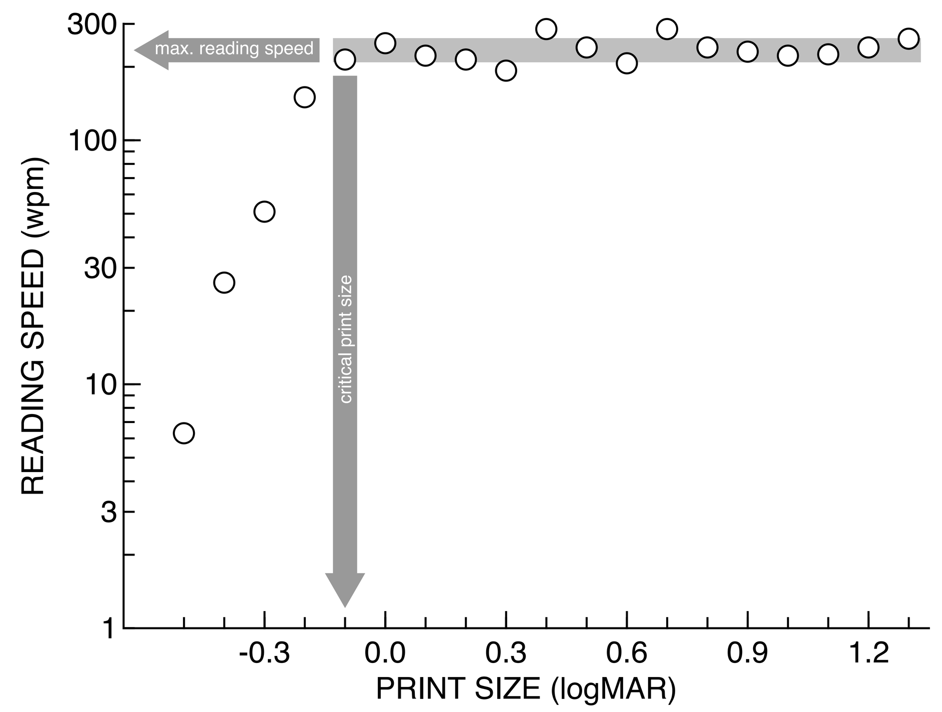


Figure 1. Typical reading-speed versus print-size data, illustrating the maximum reading speed (MRS = 220 wpm), and the critical print size (CPS = –0.1 logMAR).

- *maximum reading speed (MRS):* the reading speed when performance is not limited by print size
- *critical print size (CPS):* the smallest print that can support the maximum reading speed. This is the optimum print size for reading.

## Context in reading

Sentences typically contain contextual cues that may help the reader decode hard-to-read words.

For example, it is often easy to guess missing words:

When the sun came out the snowman started to ____.
She closed her eyes and soon fell fast ____.

## How might context affect CPS?

Using context cues could enhance word recognition at small print sizes.

**We predict that the CPS for reading sentences that contain context cues will be smaller than the CPS for reading sentences that do not contain context cues.**

## Methods

*Participants:* 90 native-English-speaking college students, with normal or corrected-to-normal vision.

*Procedure:* Reading-speed was measured at 10 print sizes (between -0.3 and +0.6 logMAR) using:

- normal sentences (which contain context cues):

  My father takes me
  to school every day
  in his big green car

- shuffled sentences (containing fewer context cues):

  in day car big takes
  school me green to
  his My every father

The sentences were selected randomly, without replacement, from a pool of one hundred 60-character sentences.

The students were timed as they read each sentence aloud. Reading speed was calculated as the number of words read correctly divided by the reading time.

## Analysis

Reading-speed versus print-size data were fit with asymptotic curves of the form:

$$\log WPM = A\ [\ 1 - e^{-e^{B(\text{print-size} - C)}}\ ] \quad (1)$$

where:

- $A$ is the reading-speed asymptote, corresponding to the maximum reading seed (MRS),
- $B$ is the logarithm of the rate constant, corresponding to how steep the curve is, and
- $C$ is the the print size at which reading speed is 0 logWPM (i.e., 1.0 WPM).

These curves, which conveniently parametrize reading-speed versus print-size data (Cheung, *et al.*, 2008), were calculated using the NLME package in *R* (Pinheiro & Bates, 2000).

The CPS was defined as the print size at which reading speed was 85% of the MRS. (shown in Figure 2).

## Results

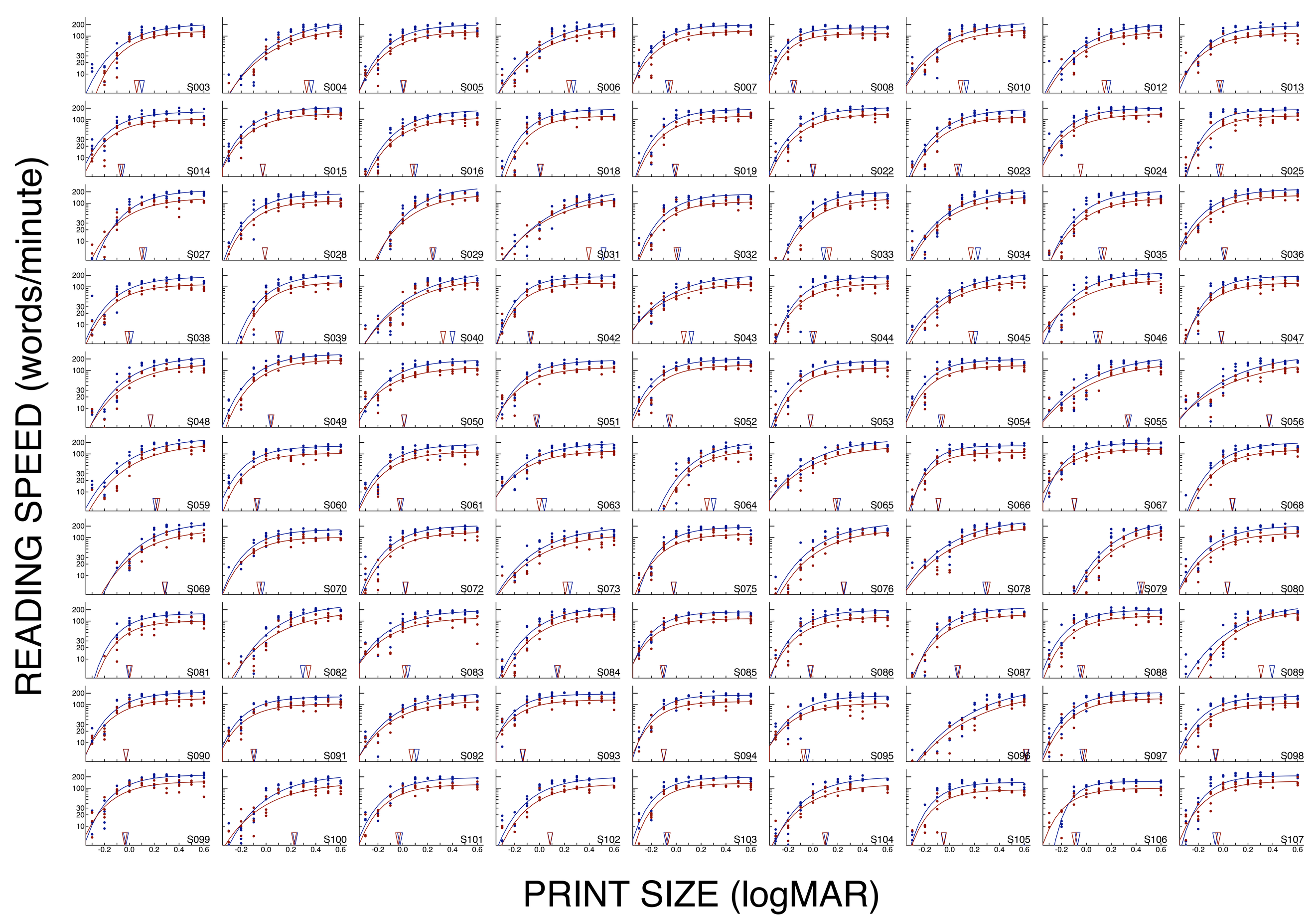


Figure 2. Reading speed as function of print size for normal (blue) and shuffled (red) sentences from all 90 students, are shown along with the best-fitting curves from Equation 1. The critical print size for each curve is shown thus: ∇.

Contrary to our prediction, the CPS for normal sentences was **2% larger** (Cohen's $d$ = 0.31) than for shuffled sentences ($t$=3.84, df=89, $p$<0.01).

In additional analyses we calculated each student's:

*Context advantage* — the difference in their maximum reading speeds (MRS) for normal versus shuffled sentences.

*CPS difference* — the difference in their critical print size (CPS) for normal versus shuffled sentences.

Students who have a larger context advantage also have a larger CPS for normal sentences than for shuffled sentences.

The correlation between context advantage and CPS difference is +0.72 (Figure 3).

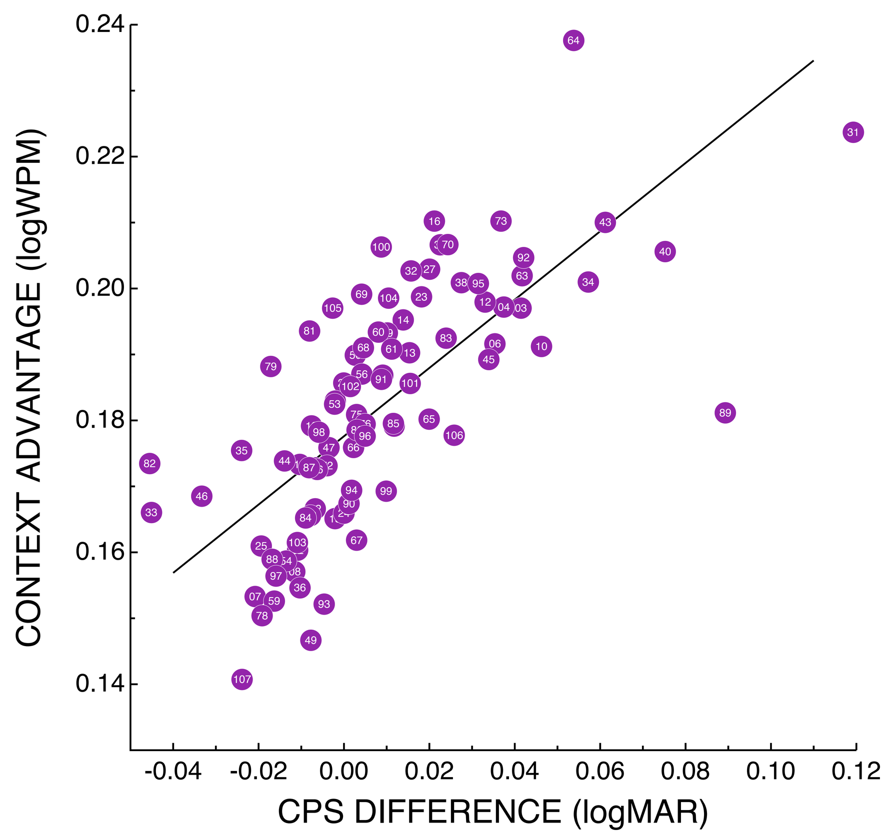


Figure 3. Context advantage ($MRS_{normal} - MRS_{shuffled}$) and critical-print-size difference ($CPS_{normal} - CPS_{shuffled}$) for the 90 students.

## Conclusions

These findings suggest the mechanisms that enable speeded context-dependent reading are very fragile and cannot tolerate small print.

Also, the dependence of CPS on context underlines the importance of using continuous text (and not random words) on tests of visual function for reading.

## References

Cheung, S-H., Kallie, C. S., Legge, G. E., Cheong, A. M. Y. (2008). NLME modeling of MNREAD data. *Investigative Ophthalmology and Vision Science, 49*, 828-35.

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