Can abbreviations improve reading speed in low vision?

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Introduction

We are studying a new approach for improving the reading performance of people with low vision.

Low vision is a visual impairment, not correctable by standard glasses, contact lenses, medicine, or surgery, that interferes with a person's ability to perform everyday activities.

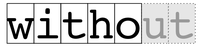
Low vision can have a drastic impact on reading performance, because visual impairments limit the visual span (i.e., the number of letters that can be recognized at a time)

With normal vision 10 or more letters can recognized on each fixation during reading. With low vision the visual span can be considerably smaller — down to the extreme of reading only one letter at a time. This visual span reduction places a bottleneck on visual processing that directly limits reading performance (Legge, Cheung, Yu, Chung, Lee, & Owens, 2007).

Reading is slow with a small visual span because fewer letters are recognized at a time, and so more eye movements are required to read all the text (Legge, 2007).

Two routes to make reading easier

A) Expand the span



B) Compress the text

Figure 1. Different approaches to improve low-vision reading. A) Training could be used to expand the span. B) Abbreviations could be used to compress the text so that fewer eye movements are required to read all the text.

A) Expand the span

Patients could be trained to use a larger visual span despite their visual impairments.

This approach has had some success. Chung, Legge, and Cheung (2004) showed that training people to read using their peripheral vision increases the visual span at that peripheral location and improves reading speed.

B) Compress the text

The text could be abbreviated to squeeze more information into the visual span.

Abbreviations reduce the redundancy in printed English, so that the information is conveyed by less text.

For this strategy to work the abbreviations should be:

- **highly compressive** — the more the text is shortened, the greater the potential benefit to the reader.
- **easy to decode** — otherwise any benefit of the reduced length may offset by the cognitive demands needed to decipher the abbreviations

An abbreviation scheme that meets these requirements is not immediately obvious

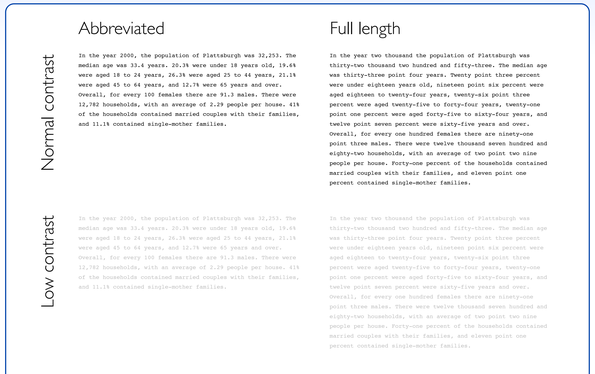


Figure 2. Example passage shown in all four conditions

Our study

We have tested the feasibility of the '*compress the text*' approach.

We compared reading speeds for full-length versus abbreviated texts for normal reading conditions and simulated low-vision reading conditions.

We anticipate that, in the low-vision condition (where reading performance is limited by eye movements), the abbreviated texts will be read substantially faster than the full-length texts.

Methods

Participants

Measures were obtained from 51 students enrolled in *PSY101 General Psychology*, with normal or corrected-to-normal vision.

Texts

We created paragraphs (100-200 words long) that contained many numbers. We made abbreviated versions of these paragraphs by by replacing written-out numbers with their digit equivalents (e.g. `Twenty four` ⇒ `24`, see Figure 2).

Digits are convenient for our study: they are familiar to students, easy to read, and they reduced the paragraphs by 50%.

The paragraphs were displayed using either normal contrast (black text) or low-contrast (faint gray text).

Contrast reduction simulates the visual impact of some causes of low vision such as cataracts, corneal opacification, etc.

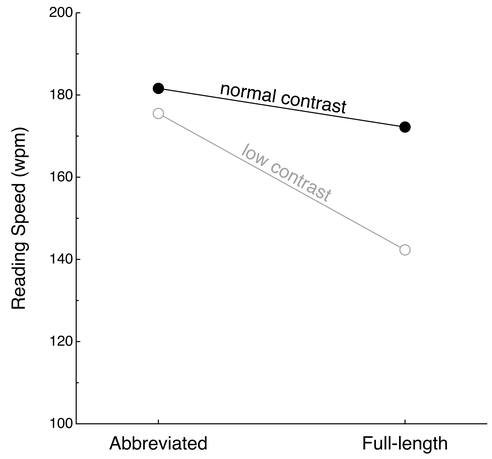


Figure 3. Normal and low-contrast reading speeds for abbreviated and full-length paragraphs.

Procedure

- The students were timed as they read each paragraph aloud. Reading speed was calculated in words per minute (wpm).
- There were 4 practice trials followed by 8 experimental trials (two paragraphs for each condition).
- The order of the paragraphs, contrasts, and abbreviation conditions, was determined randomly for each participant.
- In separate measurements we verified that the visual span for reading the low-contrast text was 60% (on average) of the visual span for normal-contrast text.

Results

- With low-contrast, abbreviated paragraphs were read 23% faster than full-length paragraphs ($p < 0.001$) (see Figure 3).
- With normal-contrast, abbreviated paragraphs were read only 5% faster than full-length paragraphs ($p < 0.001$).
- Students who were slowed the most by low-contrast tended to benefit the most from abbreviations, $r = -0.73$ (see Figure 4).

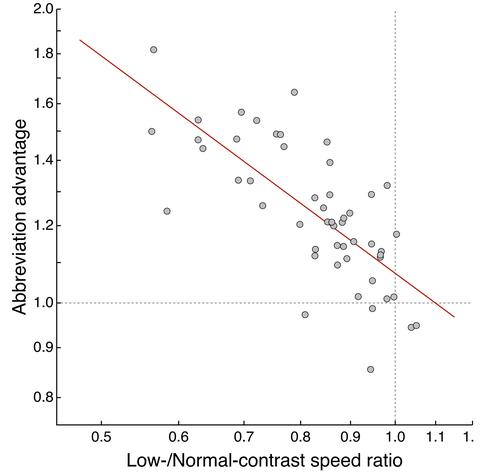


Figure 4. Reading-speed advantage for abbreviated low-contrast paragraphs as a function of the ratio of reading speeds for low- versus normal-contrast full-length paragraphs.

Conclusion

- Abbreviations produce substantial reading speed gains when reading with simulated low-vision.
- The search is now on for an abbreviation scheme that can realize these benefits in everyday reading materials for people with visual impairments.

References

Chung, S. T. L., Legge, G. E., and Cheung, S.-H. (2004). Letter-recognition and reading speed in peripheral vision benefit from perceptual learning. *Vision Research, 44*, 695–709.

Legge, G. E. (2007). *The Psychophysics of Reading in Normal and Low Vision.* Lawrence Erlbaum Associates, New Jersey, USA.

Legge, G. E., Cheung, S.-H., Yu, D., Chung, S. T. L., Lee, H.-W., and Owens, D. P. (2007). The case for the visual span as a sensory bottleneck in reading. *Journal of Vision, 7(2):9,* 1–15. 14.