To justify or not to justify? Why bad typography may be harmful for your readers

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1 Introduction

One of the most well-known algorithms in TEX is the famous hyphenation algorithm, which implements true justification. Some other computer typesetting systems do not bother with hyphenation, just increasing spacing between the words until the lines of text have the same width. While this method is frowned upon by typesetters, it is a valid question whether it makes a measurable difference for readers. This question is especially important for readers with cognitive impairments, for example, post-stroke patients.

In one of our previous works [1] we studied the difference in reading speed and comprehension between justified hyphenated text, *and* ragged right non-hyphenated text. It showed that justified texts were read slightly faster than ragged right, but on delayed (see below) tests gave slightly worse results. However, one can argue that in [1] we measured two different factors: justification and hyphenation, and their influence was confounding. Fortunately, TEX allows us to separate them, and study hyphenation and justification separately.

In this work we compared the speed of reading and comprehension of two sets of unhyphenated texts: justified ("sloppily justified", using LATEX terminology), and ragged right. We measured these factors for post-stroke patients.

2 Experimental methods

The experimental methods were the same as in our previous papers [1–4]. A group of $n = 20$ post-stroke patients (Ufa, Russia) was given two texts, A and B. Each text was typeset with LATEX using ParaType Serif fonts. Half of the participants were given text A justified and text B ragged right, while the other half had text B justified and text A ragged right. The participants were asked to read the text. After a minute they marked their current reading position. Immediately after the reading the participants were given a multiple choice test (10 questions with 4 variants of answers to choose from). To test long-term memory, we repeated the test 60 minutes later.

The Babel package and `\selectlanguage{nil}` was used to switch off hyphenation. The justified texts were typeset with the setting `\sloppy`. The ragged right texts were typeset with `\raggedright`.

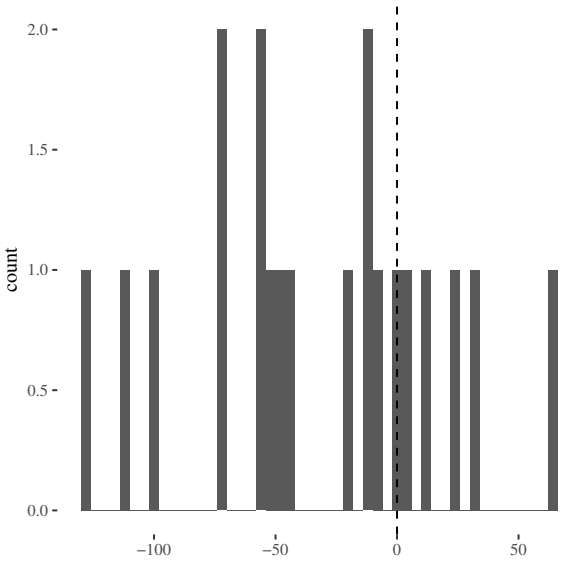

Figure 1: Histogram of difference between justified and ragged right in reading speed results (words per minute).

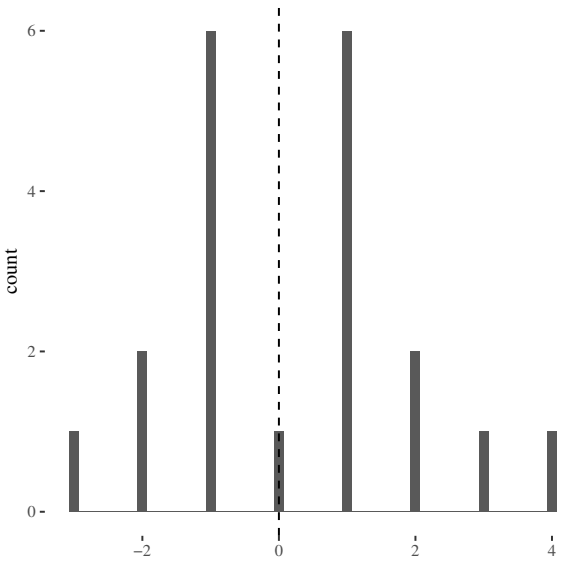

Figure 2: Histogram of difference between justified and ragged right in immediate comprehension results (correct answers).

3 Results

The results of the experiment are shown in Figures 1, 2 and 3. While there is no noticeable difference between justified and ragged right texts with respect to reading comprehension (in either immediate or delayed tests), there *is* a difference in reading speed: sloppily justified texts are being read significantly *slower*: $p = 0.01$. The average difference was -32.3 words per minute.

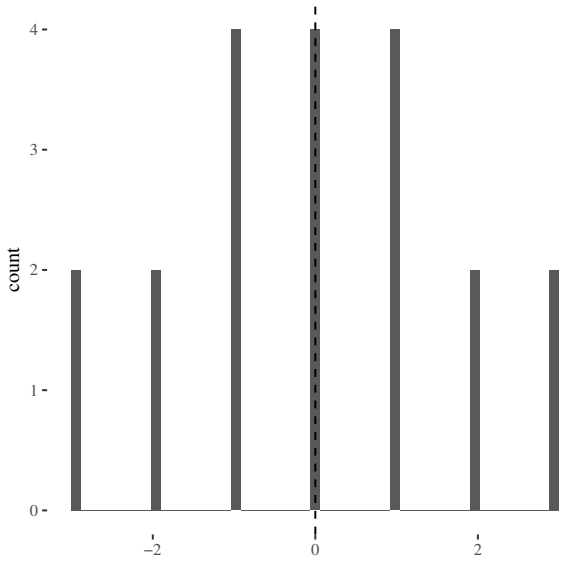

Figure 3: Histogram of difference between justified and ragged right in delayed comprehension results (correct answers).

4 Discussion

The results of this study provide an interesting complement to the conclusions of [1], where the difference in speed of reading between justified and ragged right texts was quite small — unlike our present results.

It is unknown what causes this difference between "sloppily" justified and ragged right texts. One can speculate that uneven spacing between the words produced by "sloppy" justification disturbs reading, especially for patients with cognitive challenges.

Of course our sample was quite small. However, if the results hold, they might have important practical implication. Namely, they suggest that it is better not to justify at all than to justify without hyphenation. Or, to say it succinctly, `\sloppy` is not your friend.

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