Typography and readability: An experiment with post-stroke patients

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Abstract

Typography for challenged readers has unique problems. There is a large amount of research about reading by people with impaired vision. Since reading is a complex process, other impairments, for example, cognitive problems, may also influence it. Should a publisher of texts for this audience be aware of this? Which typographical devices must be used for these texts?

In our previous reports we showed that serifs do not influence the readability and understandability of texts by healthy students. In this report we study the readability and understandability of serif and sans-serif texts by post-stroke patients. We discuss the experimental setup and preliminary results.

1 Introduction

There is a certain typographic lore about the influence of different typographic elements on readability. For example, every beginner "knows" that text with serifs is read faster than sans serif, and therefore the former should be used for body copy, and the latter for advertisements and slides. Like the remedies of traditional medicine, some of these pieces of knowledge turn out to be corroborated by evidence, while some do not.

Some time ago we discussed an evidence-based approach to the verification of these old wisdoms [5]. TEX and friends turned out to be useful in this approach since they provide repeatable controlled typesetting, where we can change a limited number of parameters and study their influence on the results.

One of the first applications of this approach was to test the hypothesis of difference in readability of serif and sans serif fonts. Our experiments with the volunteer students of Bashkir State Medical University [1, 6] showed no discernible difference between these fonts, when either the speed of reading or text comprehension were measured. This result resembles the finding by Legge and Bigelow [3] — font sizes used in the modern and historical typography are within the range of fluent reading. Our experiments indicate that not only font sizes but other typographic features as well are within this range.

These conclusions are based on the experiments with healthy readers. It is still an open question whether subtle typographic differences influence readability for people with different kinds of impairment. A prime example of such a group is post-stroke patients. It is well-known [4] that post-stroke patients often suffer from reading problems which adversely influence their adaptation. The study of whether these patients can better read serif or sans serif texts has a considerable practical importance: many materials are printed for this audience (instructional texts, drug leaflets, etc.), and the optimal use of typographic devices is clearly desirable.

Paratype Serif
Paratype Sans

Figure 1: Fonts used (enlarged to show the difference)

We have started a study of reading by post-stroke patients. In this paper we report the setup and the first preliminary results.

2 Methods

We selected the patients for this study according to the following criteria:

1. Post-stroke patients;
2. Ability to read text;
3. Fluency in Russian language;
4. Absence of dementia;
5. Absence of aphasia.

The study's methods resemble those of our previous works [1, 6]. We typeset four one-page texts in Russian using the Paratype fonts (shown in Figure 1) at 12 pt scaled 0.95 [2]. We measured the reading time of the page by the patients, and then asked them to answer 10 multiple-choice questions about the text (each question had four suggested answers).

Due to ethical considerations, all texts contained information useful for the patients: advice for post-stroke rehabilitation. To facilitate paired comparisons, we asked each patient to read all four texts with an interval of approximately one week between the texts. According to a randomized choice (using `http://www.randomization.com`) half of the patients read odd-numbered texts (1 and 3) in the serif font, and even-numbered texts (2 and 4) in sans serif, while the other half read odd-numbered texts in sans serif, and even-numbered texts in the serif font.

3 Preliminary results

At this point we can report the results for $N = 19$ participants, including 12 males and 7 females, average age 54 ± 11 years.

First, it is interesting to compare their results with those of healthy students [1, 6], who read a different text on the history of science. These comparisons are shown in Figures 2 and 3. We see that

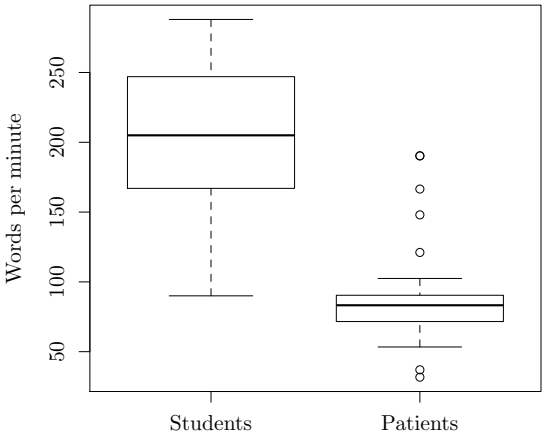

Figure 2: Comparison of speed of reading for medical students and post-stroke patients

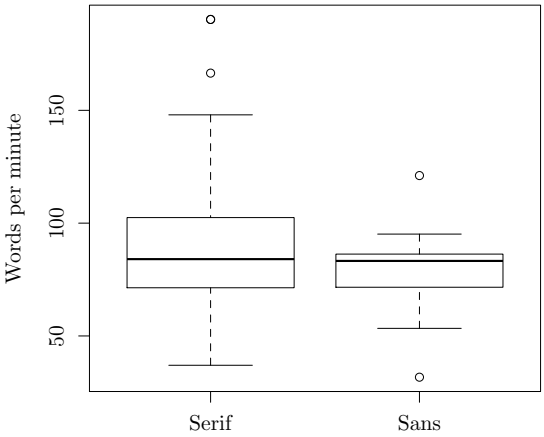

Figure 4: Comparison of speed of reading by patients for different fonts

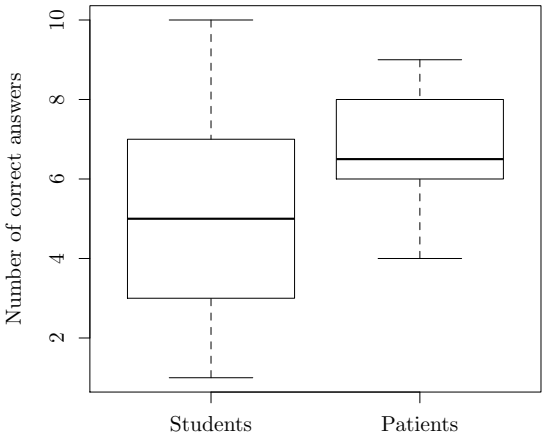

Figure 3: Comparison of reading comprehension for medical students and post-stroke patients

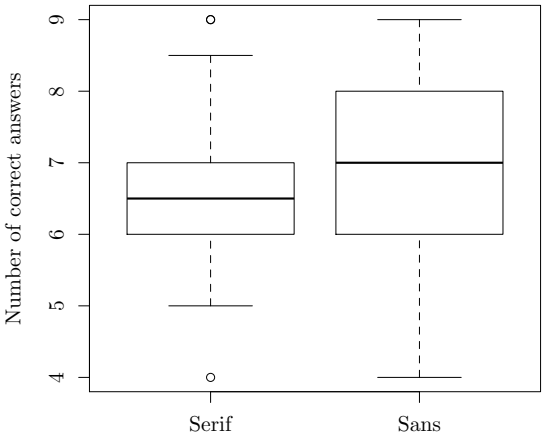

Figure 5: Comparison of reading comprehension by patients for different fonts

students definitely read faster than patients (on the average 207.13 words per minute vs. 87.84 words per minute with $p = 6.18 \times 10^{-26}$). A rather unexpected fact is that the number of correct answers is *higher* for patients (5.23 vs. 6.78 with $p = 5.19 \times 10^{-7}$). One might argue that the patients were more motivated to learn the information related to their health than students the historical information.

Let us now compare the reading of serif and sans serif fonts by the patients. This is shown in Figures 4 and 5. The figures show that there is not much difference between serif and sans serif fonts. A mathematical expression of this impression is the so-called Student's t-test. It gives $p = 0.13$ for the reading speed and $p = 0.68$ for the reading comprehension. Such values usually show low statistical significance of the measured difference.

Another way to analyze the data is to perform *paired comparisons.* Instead of looking at the averages, let us check how much the reading of serif and sans serif texts differs for the same patient. To visualize this, let us put the values for serif fonts on the x axis, and the values for sans serif fonts on the y axis. Each patient is a data point on this plot. If the data tend to cluster in the upper left part of the plot, then values for sans serif are greater than those for serif. Otherwise the opposite is true.

The results are shown in Figures 6 and 7. Again, there seems to be no difference between the fonts on average. So-called paired t-tests confirm this observation, giving the values $p = 0.14$ and $p = 0.88$, respectively.

While there was no difference in general, some data points on the figures are far from the diagonal. This means that there were patients for whom the choice of fonts made the difference.[1] The small

[1] We are grateful to Karl Berry for this observation

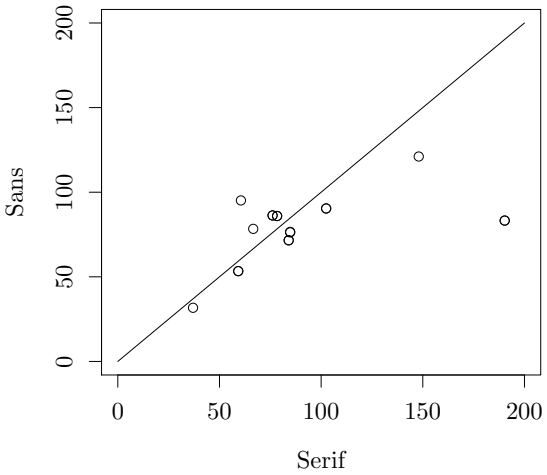

Figure 6: Paired comparison of speed of reading by patients for different fonts

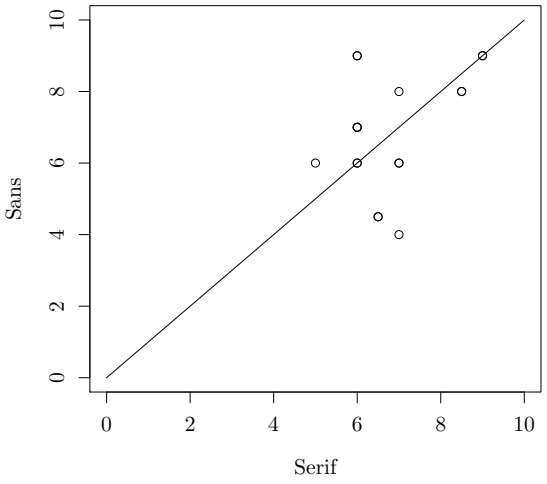

Figure 7: Paired comparison of reading comprehension by patients for different fonts

number of patients does not allow us to say at this point whether these points are outliers, or tell an interesting story about individual perception of fonts by some patients. We plan to provide an in-depth study of these patients.

4 Conclusions

The reading by post-stroke patients is an important and interesting topic of research. So far our results, while obtained with a very low number of patients, show that they, like healthy readers, read with the same speed and comprehension both serif and sans serif texts.

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References

[1] Leyla Akhmadeeva, Ilnar Tukhvatullin, and Boris Veytsman. Do serifs help in comprehension of printed text? An experiment with Cyrillic readers. *Vision Research*, 65:21–24, 2012.

[2] Pavel Farář. *Support Package for Free Fonts by ParaType*, May 2011. `http://mirrors.ctan.org/fonts/paratype`.

[3] Gordon E. Legge and Charles A. Bigelow. Does print size matter for reading? A review of findings from vision science and typography. *J. Vision*, 11(5)(8):1–22, 2011. `http://www.journalofvision.org/content/11/5/8.long`.

[4] Debjani Mukherjee, Rebecca L. Levin, and Wendy Heller. The cognitive, emotional, and social sequelae of stroke: Psychological and ethical concerns in post-stroke adaptation. *Top Stroke Rehabil*, 13(4):26–35, 2006.

[5] Boris Veytsman and Leyla Akhmadeeva. Towards evidence-based typography: Literature review and experiment design. *TUGboat*, 32(3):285–288, 2011. `http://www.tug.org/TUGboat/tb32-3/tb102veytsman-typo.pdf`.

[6] Boris Veytsman and Leyla Akhmadeeva. Towards evidence-based typography: First results. *TUGboat*, 33(2):156–157, 2012. `http://www.tug.org//TUGboat/tb33-2/tb104veytsman-typo.pdf`.

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