

Supplemental Material for

Guidelines for effective usage of text highlighting techniques

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The document at hand provides additional, detailed, and raw information about results of the evaluation and the evaluation tool that was used.

1 Evaluation Tool

The evaluation tool was implemented with the JavaScript Platform meteor¹. Participants in the study were presented with the following sequence of webpages:

1. The **intro page** explains the test procedure and provides screenshots of the test system. Participants can also start the evaluation system in test mode and play with it without anything being recorded. See Figure 4a.
2. The **consent form** provides a consent form and has to goal of reaching an informed consent. The participant consents by using the button "I consent". See Figure 2.
3. The participant is asked for **demographic data**: age group, gender, if a desktop or tablet is used, and a color blindness test. Figure 3 shows the respective page.
4. The participant is introduced to the next task (Figure 4a) and after clicking "start" the test starts (Figure 4b).
5. After time is up, the participant gets back to study introduction screen (Figure 4a) which gives feedback on performance in the lower left corner. The previous step and this step are repeated for all trials.
6. At the end, the participant can give textual feedback and is provided a reward code to receive the Amazon Mechanical Turk payment.

2 Study Results

Figures 5 and 6 show study results in the following order:

- study 1 results for reference: matrix M_1
- the normalized raw results (M_2, M_3) for pairwise combinations (with distractor or conjunctive highlight)
- the absolute difference between the raw results and the results for study 1 arranged as columns: $M_2 - \{M_1^T, M_1^T, \dots\}$
- the relative change $M_2 / \{M_1^T, M_1^T, \dots\}$

¹<https://www.meteor.com/>

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Perceptually Ranking Text Highlighting Techniques

Task: You will click on highlighted text, repeatedly, within a set time limit (13 sec). Each click requires **precision**, and you must click as **many as possible within the time**. This task will be repeated several times. Each successful click increases your point score, while false answers decrease your point score. Goal is to reach a high score. The HIT should not take more than 25-30 minutes in total.

The procedure:

- **Important:** Test the system [here](#). You should see the start button without scrolling. Don't use this link to do the test !!
- Read and agree to the consent form.
- Provide demographic information.
- Take the test and have some fun. Be PRECISE and FAST!!
- Get paid.

The system: Here you see some screenshots of the test system:

The intro page shows you the features you should look for in the next run. Be sure that you can see the "start" button.

The gray box contains the non meaningful text with some words highlighted. These highlighted words should be clicked. As soon as a word is clicked it becomes green (correct) or red (incorrect). Above the box you see an example text that is using the current highlighting technique.

Figure 1: Evaluation tool – Intro page. The **intro page** explains the test procedure and provides screenshots of the test system. Participants can also start the evaluation system in test mode and play with it without anything being recorded.

Consent Form

Study Title: Perceptually Ranking Text Highlighting Techniques

Researcher: Hendrik Strobelt, PhD – Harvard SEAS

Participation is voluntary.

It is your choice whether or not you wish to participate in this research. If you choose to participate, you can change your mind and leave the study at any time. Refusal to participate, or stopping your participation, will involve no penalty or loss of benefits to which you are otherwise entitled.

What is the purpose of this research?

The purpose of this research is to find out which electronic text highlighting techniques perform best across participants.

For how long will I take part in this research?

Your participation will take approximately 25-30 minutes. You are only allowed to participate *once* in this study.

What can I expect if I take part in this research?

You will click on highlighted text, repeatedly, within a set time limit. Each click requires precision, and you must click as many as possible within the time. This task will be repeated several times. Each successful click increases your point score, while false answers decrease your point score.

What are the risks and possible discomforts?

There is minimal risk to participating in this study. You may feel uncomfortable performing the tasks under time constraints. The information you provide is anonymous and you are free to withdraw from participation at any time.

Are there any benefits from being in this research study?

We do not expect any direct benefits to you from taking part in this research. One indirect benefit of participating might be knowing that you helped researchers better understand how people perceive highlighting in electronic texts.

Will I be compensated for participating in this research?

You will receive \$2.50 for your participation in the study, paid upon completion.

If I take part in this research, how will my privacy be protected? What happens to the information you collect?

All data collected from you will be coded with a random number. The results of this research project might be made public, with information quoted in professional journals and meetings. However, no personal information will be released and all information from this study will only be reported as a group and not individually.

The information with your HIT ID on it will be analyzed by the researcher(s) and may be reviewed by people checking to see that the research has been conducted properly.

If I have any questions, concerns or complaints about this research study, who can I talk to?

The researcher for this study is Hendrik Strobelt, who can be reached at [redacted]. The faculty sponsor is Hanspeter Pfister, who can be reached at [redacted].

If you have questions, concerns, or complaints, then please get in touch:

- If you would like to talk to the research team,
- If you think the research has harmed you, or
- If you wish to withdraw from the study.

This research has been reviewed by the Committee on the Use of Human Subjects in Research at Harvard University. They can be reached at 617-496-2847, 1414 Massachusetts Avenue, Second Floor, Cambridge, MA 02138, or cuhs@fas.harvard.edu for any of the following:

- If your questions, concerns, or complaints are not being answered by the research team,
- If you cannot reach the research team,
- If you want to talk to someone besides the research team, or
- If you have questions about your rights as a research participant.

Statement of Consent

I have read the information in this consent form. All my questions about the research have been answered to my satisfaction.

If you consent to participate, please click "I consent" below.

I consent

Figure 2: Evaluation tool – consent form. It has the goal of reaching an informed consent. The participant consents by using the button "I consent".

Demographic Data

Please let us know some details about you. This data helps us to classify test results and is not used individually.

Age Group

- younger than 20 between 20-30 between 30-60 over 60

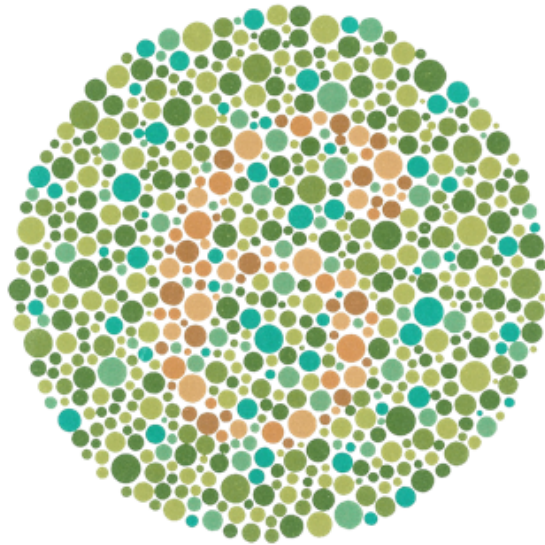
Gender

- male female no comment

Do you use a Desktop PC or a tablet ?

- Desktop PC Tablet

Which number do you see in the image below?



Submit

Figure 3: Evaluation tool – demographics. The participant is asked for **demographic data**: age group, gender, if a desktop or tablet is used, and a color blindness test.

Instruction: Please find only occurrences using **BOTH** highlights (italic typeface and bold typeface). Only this is a **valid highlight** (These highlights are **wrong** and *wrong*)

This is the test field. Please ensure that you can see the start button and you don't need to scroll down. After pressing 'Start' you have 13 seconds to get the highlights as **precise** as possible. Every non-highlight you click will account negative to the score. Before you start, please have a look above this box to see an example of the current highlight technique that will be used.

THIS IS ONLY A TRAINING SYSTEM- No results are recorded !! You will NOT get payment here.

✔ This is a **correct highlight** (italic typeface AND bold typeface)

✘ This is a *wrong highlight* (ONLY italic typeface NOT bold typeface)

✘ This is a **wrong highlight** (ONLY bold typeface NOT italic typeface)

The next test is test 1 of 46.

Start

(a) Start page introducing highlighting technique of next trial, and showing results for previous trial.

Instruction: Please find occurrences with the highlight (text shadow). This is a 'valid highlight'.

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The next test is test 2 of 18.

(b) The test page. Terms that were clicked are marked green (correct) or red (incorrect) to provide visual feedback.

Figure 4: Evaluation tool – user test. The target highlighting technique here is *shadow*.

Study 1 results (for comparison)

Values Study 1	0.86	0.84	0.78	0.76	0.74	0.71	0.58	0.55	0.15
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results for Study 2

distractor technique -->

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		0.746	0.781	0.822	0.492	0.765	0.644	0.446	0.530
border	0.661		0.790	0.794	0.772	0.760	0.505	0.588	0.525
background	0.687	0.672		0.664	0.730	0.681	0.619	0.557	0.520
red	0.649	0.693	0.781		0.652	0.634	0.582	0.545	0.511
bold	0.439	0.641	0.742	0.765		0.643	0.611	0.570	0.517
shadow	0.591	0.643	0.698	0.701	0.626		0.429	0.574	0.410
underlined	0.472	0.462	0.598	0.626	0.543	0.524		0.422	0.413
spacing	0.353	0.379	0.517	0.526	0.422	0.452	0.380		0.279
italic	0.195	0.233	0.290	0.240	0.220	0.211	0.178	0.154	

absolute changes compared to Study 1

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		-0.11	-0.08	-0.04	-0.37	-0.10	-0.22	-0.41	-0.33
border	-0.18		-0.05	-0.05	-0.07	-0.08	-0.34	-0.25	-0.31
background	-0.09	-0.11		-0.12	-0.05	-0.10	-0.16	-0.22	-0.26
red	-0.11	-0.07	0.02		-0.11	-0.13	-0.18	-0.21	-0.25
bold	-0.30	-0.10	0.00	0.03		-0.10	-0.13	-0.17	-0.22
shadow	-0.12	-0.07	-0.01	-0.01	-0.08		-0.28	-0.14	-0.30
underlined	-0.11	-0.12	0.02	0.05	-0.04	-0.06		-0.16	-0.17
spacing	-0.20	-0.17	-0.03	-0.02	-0.13	-0.10	-0.17		-0.27
italic	0.05	0.08	0.14	0.09	0.07	0.06	0.03	0.00	

relative changes compared to Study 1 in %

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		-15.35	-10.12	-4.57	-74.75	-12.46	-33.51	-92.89	-62.12
border	-27.11		-6.34	-5.82	-8.77	-10.58	-66.44	-42.83	-59.93
background	-13.48	-16.04		-17.51	-6.78	-14.49	-26.06	-39.98	-50.00
red	-17.18	-9.65	2.68		-16.54	-19.92	-30.48	-39.41	-48.81
bold	-68.61	-15.50	0.26	3.29		-15.13	-21.10	-29.90	-43.24
shadow	-20.11	-10.40	-1.72	-1.34	-13.45		-65.36	-23.76	-73.26
underlined	-22.83	-25.55	2.99	7.31	-6.85	-10.63		-37.35	-40.39
spacing	-55.97	-45.31	-6.37	-4.48	-30.30	-21.75	-44.60		-97.25
italic	23.20	35.59	48.27	37.60	31.93	28.84	15.64	2.54	

Bold cell shows significance at 0.05; **Bold and Underlined** cell shows significance at 0.01.

Figure 5: Study 2 results – more detail is provided in the Study Results Section (Section 2) of this document and in Section 5 of the publication

Study 1 results (for comparison)

Values Study 1	0.86	0.84	0.78	0.76	0.74	0.71	0.58	0.55	0.15
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results for Study 3

distractor technique -->

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		0.74	0.78	0.79	0.65	0.75	0.73	0.55	0.50
border	0.74		0.69	0.80	0.73	0.63	0.47	0.74	0.48
background	0.78	0.69		0.58	0.72	0.57	0.55	0.63	0.47
red	0.79	0.80	0.58		0.60	0.55	0.57	0.58	0.45
bold	0.65	0.73	0.72	0.60		0.58	0.55	0.55	0.45
shadow	0.75	0.63	0.57	0.55	0.58		0.40	0.50	0.35
underlined	0.73	0.47	0.55	0.57	0.55	0.40		0.64	0.29
spacing	0.55	0.74	0.63	0.58	0.55	0.50	0.64		0.32
italic	0.50	0.48	0.47	0.45	0.45	0.35	0.29	0.32	

absolute changes compared to Study 1

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		-0.12	-0.08	-0.07	-0.21	-0.11	-0.13	-0.31	-0.36
border	-0.10		-0.15	-0.04	-0.11	-0.21	-0.37	-0.10	-0.36
background	0.00	-0.09		-0.20	-0.06	-0.21	-0.23	-0.15	-0.31
red	0.03	0.04	-0.18		-0.16	-0.21	-0.19	-0.18	-0.31
bold	-0.09	-0.01	-0.02	-0.14		-0.16	-0.19	-0.19	-0.29
shadow	0.04	-0.08	-0.14	-0.16	-0.13		-0.31	-0.21	-0.36
underlined	0.15	-0.11	-0.03	-0.01	-0.03	-0.18		0.06	-0.29
spacing	0.00	0.19	0.08	0.03	0.00	-0.05	0.09		-0.23
italic	0.35	0.33	0.32	0.30	0.30	0.20	0.14	0.17	

relative changes compared to Study 1 in %

	font size	border	background	red	bold	shadow	underlined	spacing	italic
font size		-16.44	-9.70	-9.19	-32.41	-15.35	-17.68	-56.33	-71.45
border	-13.73		-21.86	-5.56	-14.31	-32.53	-77.13	-13.93	-74.89
background	0.51	-13.15		-34.67	-8.13	-37.51	-42.69	-23.85	-64.73
red	3.51	4.50	-31.22		-26.48	-39.16	-34.26	-30.59	-69.43
bold	-13.94	-0.70	-2.58	-23.16		-28.23	-34.73	-35.15	-64.45
shadow	4.77	-12.02	-25.17	-30.00	-23.03		-78.32	-43.27	-105.05
underlined	20.63	-22.30	-6.10	-2.46	-5.60	-45.67		8.89	-97.46
spacing	0.02	25.40	12.67	5.49	-0.45	-10.99	13.60		-73.93
italic	70.10	68.77	68.32	66.56	66.66	56.68	48.93	52.57	

Bold cell shows significance at 0.05; **Bold and Underlined** cell shows significance at 0.01.

Figure 6: Study 3 results – more details are provided in the Study Results Section (Section 2) of this document and in Section 6 in the publication