The Influence of Text Formatting on Comprehension and Reading Speed

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ABSTRACT

This study seeks to explore the relationship between text formatting, such as the way words are organized on a PowerPoint slide, and comprehension and reading speed. Specifically, this study will test how information presented as a bulleted list can influence a reader's understanding compared to information presented as a block of text. This study will be useful to determine best practices for text formatting techniques when presenting complex subjects to a school or other audience. In this study, participants were presented four PowerPoint slides with excerpts of information on them, formatted either as a block of text or as a bulleted list. The variance in text formatting influenced their scores on a subsequent comprehension quiz and their reading speeds. Eye movements were recorded to further explore the associations between text formats and the attention of the participants.

KEYWORDS

eye tracking, text formatting, information retention

1 INTRODUCTION

Technology now pervades every aspect of life, and none more so than presentations and information dissemination. Various studies into the effectiveness of video during presentations have been conducted (Miskam and Saldavi [2020]; Walley et al. [1995]). These studies consistently report that technology and its formatting play a pivotal role in the processing of information given through presentations, and what their effects on information retention are. However, the last study into presentation formatting through technology was Walley et al. [1995], leading to a profound gap in studies of this nature. This paper sets out to bridge this gap. We investigated

the effects of passage formatting in order to effectively communicate information in a presentation format. It was hypothesized that shorter form information would be retained easier.

2 BACKGROUND

Mézière et al. [2023] discusses the use of eye tracking measures to predict reading comprehension. The paper shows that eye tracking can be used to help predict comprehension within differing passages and tests. The paper concludes that reading speed is the main factor for comprehension, but that eye tracking measures are a useful tool, combined with other measures, to help predict reader comprehension of a passage. This paper is especially useful to this study, as it represents a way to measure comprehension which we will use in order to measure comprehension of the differing formats of information.

Nguyen et al. [2021] discusses the training of a document recognition model based on human behavior of skimming texts. The results show that the text skimming was a much more efficient model for training language models to understand and interpret documents. Some of the samples used in the study were derived from papers on arXiv and other journals, thus the papers were of high complexity. This paper is useful to describe the behaviors of skimming and whether reading time is necessarily accurate to comprehension. Lower reading time does not necessarily mean skimming is happening, and even if it is, it does not mean that the participant does not comprehend what they are reading. Thus, this paper's results need to be considered when conducting the study.

Legge and Bigelow [2011] discusses the size and legibility of text as it pertains to printed texts. The paper finds that within the "fluent zone" of 4-40 point fonts. The paper points out how larger font sizes can be used with fewer words in certain cases, such as important headlines, in order to create emphasis and encourage people to take a closer look at the other text on the material. However, conclusively, it is recommended to stay within the fluent zone. This paper is useful as it presents a baseline to use so that formatting can be done strictly through the defined experimental design, reducing a confounding factor based on the size of the text presented.

3 METHODOLOGY
3.1 Experimental Design

This is a single factorial design in which the independent variable is text format (bulleted vs. block-text) and the dependent variables are reading comprehension score and reading speed. Because no participant will read the bulleted and block-text form of the same

excerpt, this study is between-subjects. The presentation of stimuli is counterbalanced; participants were shown four different excerpts (two excerpts with block text, and two excerpts with bulleted text), and not all participants were shown the same text format on each excerpt.

3.2 Stimuli

The main stimuli used in this experiment are four PowerPoint slides containing excerpts from eye-tracking papers. The slides will have a basic design with 12", Times New Roman, single spaced, black text on them. The information may be formatted in a bulleted list, or in a block of text. Each slide will have roughly the same amount of words on them. See Figures 2 and 3 for examples of the stimuli that will be used.

3.3 Participants

The participants include 10 Clemson University students between 20 and 22 years old (8 male, and 2 female). Two of these participants wear contacts, two of them wear glasses, and one of them has astigmatism.

3.4 Procedure

Before the experiment starts, each participant will be told the following information; They will have 45 seconds to read four excerpts of information in varying text formats, with a 10 second buffer between each excerpt to reduce recency bias. These excerpts are taken from academic papers and will be presented as either a bulleted list or a block of text (there will be two of each). Afterword, they will complete a multiple choice quiz on paper to assess their reading comprehension of those excerpts.

Each participant was then informed about the GP3V2 eye tracker, and the data it will collect during the experiment. The instructor will then walk the participant through the calibration process, making sure the participant knows to stay within the range of the eye tracker so it doesn't lose its calibration.

Afterword, the participant will start the experiment. After the participants finish the information retention quiz, their answers will be collected and they will be instructed to leave, while the experiment
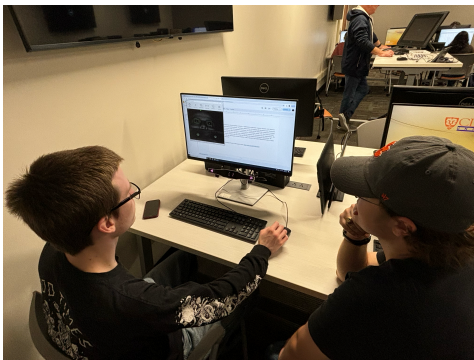

Figure 1: Eye tracker setup with Gazepoint GP3.

Figure 2: Block-Text Stimuli Example

Figure 3: Bulleted Text Stimuli Example

is reset and prepared for the next participant.

The quiz is the same regardless of the text format of each excerpt. All questions come directly from the text and are able to be answered with the information in both versions of each excerpt. Areas of Interests (AOIs) were placed on every few words of all 8 possible stimuli (2 different formats for each excerpt) to investigate the effect of text format on reading speeds. The average time spent on each AOI, and the average words per minute (wpm) reading speed was calculated for all bulleted excerpts, and all block-text excerpts.

3.5 Apparatus

A Gazepoint GP3 eye tracker was used, sampling at 60 Hz with an accuracy of $1°$ as given by the manufacturer, see Figure 1. The participant took the test on a Dell P2422H, which has a resolution of 1920x1080 pixels. The eye tracker was set up under the computer and was calibrated using Gazepoint Control with a 5-point calibration process. The OS of the computer used was Windows 10, and the software used to administer the experiment was Gazepoint Analysis.

4 RESULTS

A matched pairs t-test was conducted to determine if the participants more accurately answered questions on the multiple choice quiz when the excerpt used to answer the question was formatted as a bulleted list. We hypothesized that people who saw bulleted excerpts scored higher on the questions for that excerpt on the quiz than people who saw block excerpts, so a right-tailed test was conducted. Contrary to our hypothesis however, the p-value was 0.50, indicating that at the 5 percent significance level, there is insufficient evidence to suggest that people who saw the bulleted
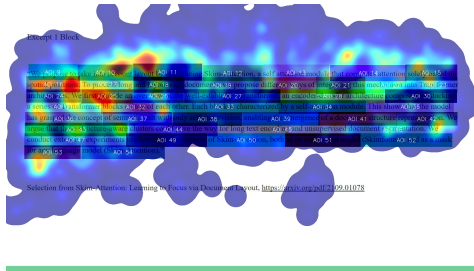
Figure 4: Heatmap of Participants Attention for Excerpt 1 Block-text

Figure 5: Heatmap of Participants Attention for Excerpt 1 Bulleted

format of an excerpt were more likely to get questions associated with that excerpt on the quiz correct.

Three key items were collected from the eye-tracking data. The first key statistic was the average time spent on each AOI, in seconds. The second key statistic was the average words per minute reading speed, which was calculated by dividing the total number of words in each stimuli by the total average time spent looking at the AOIs, in minutes. The third key item represents the heatmap of every stimuli depicting overall participant attention.

A 2 sample mean t-test was conducted to determine if the average time spent on each AOI for bulleted excerpts was less than the average time spent on each AOI for block-text excerpts. We hypothesized that people who were given bulleted texts spent less time reading the words in each AOI compared to those who were given block-texts, so a left-tailed test was conducted. Contrary to our hypothesis, the p-value was .16, indicating that at the 5 percent significance level, there is insufficient evidence to suggest that participants, on average, spent less time reading the words in each AOI for bulleted excerpts compared to block-text excerpts.

The average wpm reading speed for all bulleted excerpts between all participants was 306 wpm, while the average wpm reading speed for all block excerpts between all participants was 307 wpm. Another 2 sample mean t-test was conducted to determine if the difference between these means are statistically significant. We initially hypothesized that the average wpm reading speed would be higher on bulleted excerpts compared to block-text excerpts, so a right-tailed t-test was conducted. Contrary to our hypothesis, the p-value was 0.504, indicating that at the 5 percent significance level, there is insufficient evidence to suggest that the average wpm reading speed for bulleted excerpts is higher than that of block-text excerpts.

Heatmaps representing participant attention on the stimuli were collected. The attention heatmap for excerpt 1 block-text format is depicted in Figure 4, while the attention heatmap for excerpt 1 bullet format is depicted in Figure 5.

5 DISCUSSION

Based on the t-tests conducted from our results, there is insufficient evidence to suggest that variations of text formatting between bulleted lists and blocks of text effect reading comprehension or
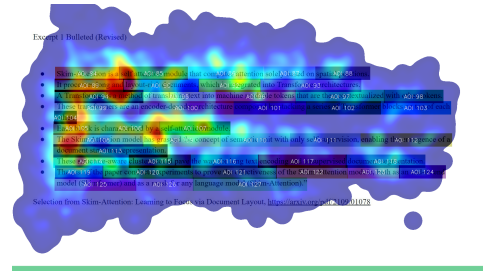
reading speed.

Despite not getting statistically significant results for the main study of this paper, a few associations can be made based on the heatmaps collected. For both bulleted and block text formats, participants' attention was highest at the start of the text. Areas of high attention, as shown in red, were initially speculated to be on words that were likely to be unfamiliar to the participants, but this was not always the case. The reason why the highest attention was measured at the start of each excerpt may be because the participants started to reread the passage before the 45 second timer expired. Also, the start of a passage may serve as an "anchor" for the eyes as the brain prepares to read and comprehend what it is seeing.

In a post-experiment Likert scale survey that was administered after each participant had completed the experiment, no participant said the font was difficult to read or that they were distracted by other parts of the presentation besides the text. This indicates that there were few outside variables that were interfering with our results. Additionally, most participants found the experiment to be neither difficult, nor easy, but their confidence in their ability to answer the multiple choice questions correctly was poor, on average. This is likely because the questions were intentionally difficult and the excerpts required high level reading skills.

6 LIMITATIONS & FUTURE WORK

One limitation of this study comes from the fact that the scores on the post-experiment quiz may be more of a test of memory than a test of reading comprehension. We tried to account for this by putting in buffers after every excerpt and limiting the excerpt reading time, but it is difficult to determine if these measures were effective.

Only 10 participants were used in the study, so, in the future, a larger sample size would help increase the accuracy of our results. Another limitation in the study is that only two formats were used in the study, so there is some gaps in what could be out there to improve information retention. In the future, this study should be repeated with more text format variants to see if there is a better way to format information in a way that people will understand.

The calculation of the average reading speed in wpm of every participant neglects the fact that if the participant finishes reading

the excerpt before the 45 second timer expires, they will reread some of the passage, increasing their time spent on each AOI. In a future study, the reading speed of each participant should be measured more accurately by giving the participants the ability to move on to the next stimuli once they've finished reading the current stimuli.

7 CONCLUSION

Reading comprehension and attention are key problems when presenting complex topics to an audience. By testing the formatting of bulleted lists and block text, this study finds that the differences in reading speed and attention capture do not significantly differ between the two formats used within the study. The implications of such lend itself towards using block text given it's ability to convey more information given that the audience has time to read and digest the information.

Future research into this topic should focus on more formats for disseminating information, as this study only covers bulleted lists and block texts. Further studies into the effect of a presenter or spoken information in conjunction with the different text formats for presentation, and perhaps even speed trials to discern the effect of time on these formats. All together, more research can be done in the field to determine definitively what captures attention and comprehension in a meaningful way.

ACKNOWLEDGMENTS

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