

Section 3. Sociology

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READING ON IPAD VERSUS PAPER: A BEHAVIORAL EXPERIMENT

Abstract. With the growing popularity and accessibility of digital reading devices, questions regarding their effect on reading comprehension arise. Fifty- four college students were randomly assigned to either experimental group or control group. Participants in the experimental group read a two-page text on an iPad and participants in the control group read the same two-page text on a piece of paper. After the 15-minutes of reading, participants completed 10 SAT questions that measured their reading comprehension on abstract information and detailed information from the two-page text. Multiple-regression analysis results showed that the two groups differed only on their comprehension of the abstract information. Besides the group factor, time spent on completing the SAT questions also predicted participants' scores on abstract questions. Consistent with some previous studies, there were no significant differences in the overall scores between the iPad and paper groups.

Keywords: reading comprehension, digital media, reading speed, technology, narrative text.

With the digital age, technology has been quietly replacing traditional media in a plethora of environments. When one walks into a library, they will inevitably see someone working on a laptop. Technology brings the convenience of being able to access an abundance of information via the internet freely. Tablets are able to store millions of words without the user having to carry around heavy books. Consumers also gain the ability to record their process with an e-reader easily. E-readers also have search functions, which allow the user to quickly look up a specific word or phrase in a piece of writing. A study on Korean middle school students showed that 30.9% of the students were at risk of smartphone addiction (Cha and Seo [2]). The prevalence of digital media is easily identifiable.

Though technology offers many advantages compared to paper, educators still have concerns about

how effective it is to read on digital media. Many teachers worry about students being more distracted when using an iPad, as compared to print media. Some students felt eye strain, were more distracted, and had increased anxiety due to the number of choices of e-textbooks (Dobler [8]). Parents also worry about whether digital media negatively affects memory. Other worries about the possible degrees of critical thinking, which positively affects reading comprehension and only occurs when the reader is deeply concentrated (Elder & Paul [12]; Hosseini et al. [14]).

Many studies show that print materials support better comprehension of the text compared to paper materials. Other studies show that reading on paper results in a deeper understanding of the text than reading on a screen (Öztop & Nayci [18]; Gąsior [13]). Öztop and Nayci's study was a meta-analysis of 12 studies, that involved reading in Turkish.

Gašior's study consisted of Polish English learners reading the same text on either paper or computer screen. Many researchers such as Öztop and Nayci recommend "improving the screen interface and screen reading skills". When participants were in a stressful environment, they understood the text least when reading on-screen than on paper (Delgado & Salmerón [7]). However, other studies such as "Screen and Paper Research" found that there were no significant differences in comprehension when reading from an e-reader versus paper (Walsh [9]).

Activity Theory may explain the difference in results of reading on the two media. Studies such as "An application of activity theory to the "problem of e-books" explains that due to a decrease of continuity of tasks, digital media diminish organization in studying and working (Kirby & Anwar [1]). The researchers applied Activity Theory to explain the cognitive processes that occur when participants read on an e-reader. Other studies present the selective attention theory called "Thought Suppression" (Chajut and Algom [15]). When processing information, humans can block off other things in the environment. Digital media may make this process more difficult. The theory of Thought Suppression suggests that people can select what they want to focus their attention on. When stressed, the brain struggles with the intended object of focus and becomes distracted. More automatic processes such as flipping a sheet of paper require less energy and provide fewer distractions (Chajut and Algom [16]). Digital media may be more tedious to navigate, forcing the brain to diverge more energy. For example, when students use paper to take the SAT, they are already familiar with the paper as a reading media. They do not need to diverge additional energy to operate the additional features that an iPad may offer. The additional highlighter, underlighting, note-taking tools, and more on an iPad are helpful features for the user in a low-stress environment. In high-stress environments, however, the additional hand-eye coordination puts additional stress on the user. These may consume

attention and make blocking distractions more difficult. In addition, the participants only comprehend the small details in the materials. Abstract questions require information integration, which in turn requires a deep understanding of the text (Chi et. al [4]). Only understanding the smaller ideas and not the overall picture may bring down the overall test score and the abstract score of the iPad group.

The reaction time may also correlate with performance. One such study shows that a faster reaction time is correlated with higher accuracy. However, a decrease in comprehension was shown when reading fast (Dyson & Haselgrove [11]). Dyson and Haselgrove found that medium-lengthed sentences contribute to the best comprehension ability. Longer scrolling time and pauses were also correlated with higher performance. Reading faster may cause readers to skip over certain essential pieces of information. They could also misremember details and insert words where there were not. Spending more time rereading text could increase the detail and abstract section scores, effectively raising the overall score.

Current Study

In this study, there were three different means of measuring comprehension. The overall score measures the general comprehension of the participant. The detailed score measures how well the participant understood details in the reading material. Finally, the abstract score measures the participant's understanding of the overall passage.

This paper aims to discuss the difference in reading comprehension in young people when reading from paper or an iPad. Students were measured by a combination of abstract and detailed questions. Abstract questions tested the participants' understanding of the more profound message the reading conveys. To answer them correctly, participants will have to gain an adequate understanding of the entire passage. To answer them correctly, participants will have to remember their rough position and go back to the passage and find the answer. It is hypothesized that the paper group will do better overall and

in abstract questions. The iPad group will do better in the detailed questions.

Method

Participants

College students from a metropolitan city in China participated in the current experiment. Any genders were welcome to the experiment. The study procedure was approved by the IRB at the study site.

Procedure

Participants were invited to the lab individually by appointment. A trained research assistant greeted the participants and read the consent form to them. Participants were able to ask questions about the form and the researcher assistant answered them. The participants were then seated in front of either an iPad or a piece of paper, containing the same passage. Both media were the same size and the same font. Participants had 15 minutes to read the passage. The passage was an excerpt from a novel. They were allowed to write down words they did not know because the passage was in English and their native language was Chinese. Afterward, they were given a dictionary to look up unfamiliar terms. Then they were asked to complete the 10 SAT questions about the reading material on either an iPad or a piece of paper. They still had access to passages and the dictionary during the testing time. The participants were allowed as much time as they needed to complete the SAT reading comprehension questions. In the end, participants completed simple demographics questions such as their major, gender, and age. The participants were then thanked and compensated about 4.63 dollars (30 RMB) for their time. The entire procedure took less than one hour. The SAT questions were found online and were publicly available practice questions for SAT reading comprehension section.

Variables

Media. A binary variable was used to denote whether the participants were assigned to the iPad or paper groups. This variable was entered in the multiple regression models as a binary categorical

variable. **Total score.** A total of 10 multiple-choice questions were used to measure participants' reading comprehension of the materials. **Abstract score.** Abstract information comprehension was measured using five of the ten questions. An example question used to measure abstract information comprehension was "Which choice best describes what happens in the passage?" **Detail score.** Detail information comprehension was measured using the other five of the ten questions. An example question used to measure detailed information comprehension was "As used in line 1 and line 65, 'directly' most nearly means?" The correct response was recorded as 1 and the incorrect was recorded as 0. If the participant left the answer blank, it was recorded as N/A. **Time.** The length of time participants spent on each section was also recorded. The results were inputted into R studio and were analyzed using multiple regression using package "rstatix".

Results

Controlling for age, gender, time spent completing the questions, and interaction between media and time, the media group did not significantly predict the total score ($\beta = -2.57, p = 0.59$), meaning that the two groups did not differ significantly on their total scores. This model achieved small effect size ($R^2 = 0.07$) according to Cohen's criteria (Cohen, 1988). Once again, the two groups scored similarly in the detailed questions of the SAT. Media group did not significantly predict detail score neither ($\beta = 1.40, p = 0.4$). This model achieved a small effect size ($R^2 = 0.10$) according to Cohen's criteria. Again, media was not a significant coefficient. In the abstract questions of the test, media was significant. Media group significantly predicted abstract score ($\beta = -3.96, p < 0.05$), with the paper group showing higher abstract scores. This model achieved medium effect ($R^2 = 0.20$).

Time spent to complete the questions was not a significant predictor for neither total score more detail score. Time spent to complete the ten questions, however, was a significant predictor for abstract score

($\beta = -0.01, p < 0.01$). Longer time spent completing the ten questions predicted lower abstract scores.

Both the interactions between time and media for the overall and detail scores were insignificant, with the overall score's p-value being -3.96 and the detail score's p-value being 0.5759 . Participants who used an iPad to take the SAT and spend more time on it

were able to get higher scores on the abstract questions. The interaction between the variables time and media shows a significant effect on abstract scores ($\beta = 0.006, p < 0.01$). Specifically, for the iPad group, longer time spent completing the questions predicted higher abstract scores ($\beta = -0.001, p = 0.19$). (Fig. 1) shows the line graph for the interaction effect.

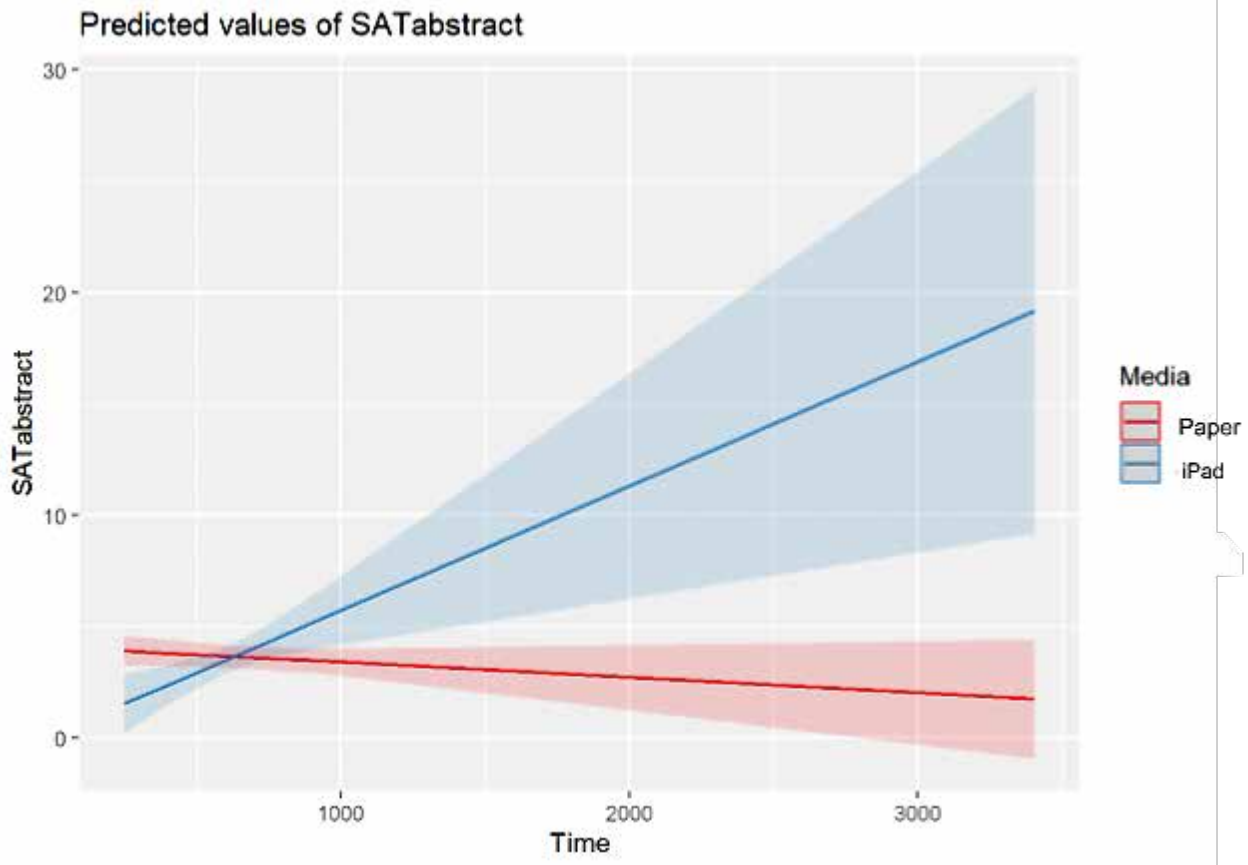


Figure 1. Predicted value of SAT abstract score in correlation with time for the paper group and iPad group

Discussion

Due to growing concerns with parents and educators about the influence of digital media in classrooms, this report was conducted to research the different aspects of reading comprehension in digital media versus paper media. This study shows that overall, the two different media do not show many differences in reading comprehension.

In the current study, there was no overall difference between the test scores of all the participants. There was also no difference in the detail sections of

the SAT of all the participants' scores. However, in the abstract section, the paper group achieved higher scores. The study was conducted by asking college students to take the SAT on either an iPad or paper. In addition, the participant's age, gender, and time took for the test were controlled.

The hypothesis states that the paper group will score higher on both the overall score and abstract questions. The results of the data analysis showed that there was no difference between the media on participants' overall results. Other studies showed

that “comprehension of the digital text was inferior to that of the printed text” (Ben-Yehudah & Eshet-Alkalai [19]). Their results contradict the current study’s findings. Another research paper states that, compared to paper, digital media has negatively affected the user’s reading comprehension (Clinton [5]). This supports the initial hypothesis. However, the author acknowledged that the results might be limited since only expository texts were present in the study. The inconsistencies in the studies may be down to questions difference, as the study by Ben-Yehudah & Eshet-Alkalai had mostly abstract questions. The study by Clinton did not state if the questions were abstract or detail-based.

Next, the hypothesis states that the iPad group will score higher on the detail questions. The results showed that, once again, the two groups did not have significant differences in this section. With a p -value of over 0.05, media did not prove to be the variable of difference. The hypothesis states that the longer the iPad group spends on the detail section, the higher their score. However, the data analysis shows that the iPad group only had a positive time and media interaction effect on the abstract items ($\beta=0.006, p < 0.05$). The hypothesis then states that the paper group will score higher on the abstract questions. This was proven true as the data had a p -value < 0.05 .

Thought Suppression Theory may explain the difference between the results and hypothesis. This theory suggests that people can repress distracting thoughts or outside elements to focus on the task at hand. Since this is a controlled experiment, the researcher assistant eliminated most of the daily life distractions for the participants. This may help the iPad group block out distractions more easily than shown in previous studies. Because there was a switch of mediums when the iPad group was studying versus taking the SAT (from iPad to a laptop), this might take extra adjusting. However, if the user has plenty of experience with either digital media, taking the test on either would not significantly impact performance (Ling [9]).

Additionally, the iPad group had access to highlighter tools. Previous research has shown that highlighting important texts help improve memory and attention (Nishimur & Kuwahara [17]). The iPad group also could use the provided notepad inside the program in which the participants took the test. Studies have shown that note-taking under time restraints reduced the students’ distractedness and increased performance (Wu & Xie [2]). Therefore the paper group may have been able to perform even better if they were provided with the same materials.

Limitations

Of course, there are many limitations to the present study. First, this study only studied the difference between reading on iPad and reading on paper; it does not include other e-reader devices. A Kindle may be less or more distracting than an iPad because of the different screen textures. Future studies could include more media for participants to read on. Additionally, this study only included college-age students. A different age group may not achieve the same results. For example, toddlers may be much more distracted by an iPad than they are with paper. Future studies could include a larger sample size that includes all the age groups. They may need to have multiple groups for children under 15 because their brains develop each year rapidly. More intervals may provide a more accurate result of children’s performance. The participants were also in a stressful environment. Results may differ for different environments. Future studies could include more conditions. Since the test was found online and public, there may be chances that the participants had viewed it before. For the most accurate result, future research could make their own tests. Additionally, the amount of experience the participant has with technology affects their digital reading comprehension (Delgado et al. [10]). Future studies could provide surveys to better understand the participants’ level of familiarity with technology.

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