

# Print Versus Digital

What Does the Latest Research Say?

WHITE PAPER

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## INTRODUCTION

Content is a little like water flowing downhill after a rainstorm. It follows the path of least resistance. Want to communicate with someone standing next to you? How about you just talk to them? Want to get that same message to someone on the other side of the earth? You may want to get satellites involved.

The path of least resistance is generally the easiest route for water (and content) to follow. In the case of content, that is often the least expensive path—which may not always be the most effective one. This brings us to the ongoing debate about the value of print in an increasingly digital world. In what situations is print the better option—particularly when content providers are faced with the ubiquity of on-screen offerings?

Fortunately, a significant amount of research has been done on this topic. In this white paper, we will focus on multiple studies related to three important aspects of content delivery:

- ◆ The ability to focus
- ◆ The level of comprehension
- ◆ Personal preference

## ANALYSIS

### The Ability to Focus

A May 2023 study<sup>1</sup> of 15 second and third graders in Haifa, Israel provides new evidence supporting the value of print. The study examined brain wave activity and concluded that reading on paper stimulated key parts of the brain more effectively than reading the same text on screen. This study has important implications for the ability to focus.

#### Brain Waves, Media, and the Ability to Focus

You will need a PhD to read the actual paper, but just imagine this: a person in a lab coat asks a seven-year-old to sit down. They then place a special cap on the child's head and fasten a strap under their chin. The head-worn device looks a

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<sup>1</sup> "Higher theta-beta ratio during screen-based vs. printed paper is related to lower attention in children: An EEG study" by Michal Zivan, Sasson Vaknin, Nimrod Peleg, Rakefet Ackerman, Tzipi Horowitz-Kraus. Edited by Wajid Mumtaz. The study was funded by the Alon Fellowship for Outstanding Young Researchers. Council of Higher Education, Israel. To see the full study, go to <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10194945/>.

bit like an old-fashioned ladies' swimming cap, but instead of rubber flowers, it is covered with electrodes capable of reading brain waves. The child is then asked to read two age-appropriate, 100-word texts without illustrations. This is followed up by a set of five questions. The test is repeated once with the text being on paper and another time when the text is on screen (the order is randomized across the participants).

Figure 1: Easy Cap EEG Recording Cap



Source: Easy Cap GMBH

The children have been tested in advance to be sure that they have no neurological or developmental issues. They have been offered a gift valued at \$25 for their trouble. The number of children in the study (15) was selected to afford an 80% level of accuracy.

The purpose of the study was to examine the differences in “brain activation” when reading from a screen compared to reading from a printed paper. The electroencephalogram (EEG) data that was collected via the electrode cap focused on two types of brain waves related to language: visual processing and cognitive control. The researchers concluded that when reading from a printed paper, children’s brains showed higher energy in high-frequency beta and gamma bands, while their brains showed higher power in lower frequency alpha and theta bands when reading from a screen. What in the world is this supposed to mean?

One important takeaway is that when there is higher power in the theta bands, as occurred when viewing text on a screen; it means that the person has challenges in allocating attention to a given task, such as reading. This is a fancy way of saying that it is harder to focus when reading on screen, even when there are no other distractions on the digital device. The second and third graders in

this research had no other screen distractions during the test (though this is certainly not the case for the rest of us using smart phones and computers). The researchers use the term “screen inferiority” to describe the results of studies in which participants who read texts digitally performed worse than those who read printed texts.

## The Results of the Study

The researchers went into the study with the following hypotheses:

- ◆ Participants reading on screen would show brain waveforms associated with lower attention allocation and mind wandering. The resulting research supported this hypothesis.
- ◆ Reading from a printed paper would be accompanied by higher energy in higher frequency bands. This was also supported by the data.
- ◆ Brain wave activity will occur in areas associated with a “decreased performance in the attention task” (aka daydreaming). This was supported by the data.
- ◆ The authors expected that reading on paper would result in higher reading comprehension scores than on-screen reading. This was not supported by the data. No significant differences in comprehension were found between screen and print reading.

Long story short, the study provides brainwave evidence that a child’s attention is overloaded when exposed to information on screens. And though it is true that print comes out as the winner in this study, the win is not about comprehension. It is about the ability to focus. The authors note that other studies have shown that comprehension is better with print, but they admit that their study did not show that. The authors categorically state: “...Our study did not find media effects on comprehension levels.” In other words, the children’s comprehension level was the same for paper and screen.

## Comprehension

The previous study was interesting in what it showed about a child’s ability to focus, but its authors did not see any difference in comprehension between screen and print. They admit that a study of young children reviewing very short written passages may not be the best way to understand the impact of paper versus digital on comprehension. Other studies, they point out, do show comprehension differences generally in favor of print (with some exceptions). They cited the following studies (including some described as “meta-analysis,” which basically means that they drew their conclusions by reviewing other studies rather than doing one of their own):

- ◆ Don't throw away your printed books: A meta-analysis on the effects of reading media on reading comprehension by Pablo Delgado, Cristina Vargas, Rakefet Ackerman, and Ladislao Salmerón (2018). These researchers concluded that:
  - Reading on paper results in better comprehension than digital-based reading.
  - Paper's advantage was clearer for informational texts (rather than narrative ones).
  - Paper-based comprehension has improved since 2000.
- ◆ Comparison of reading performance on screen and on paper: A meta-analysis by Yiren Kong, Young Sik Seo, and Ling Zhai (2018). These researchers found that:
  - Reading on paper was better than reading on screen in terms of comprehension, but not in terms of reading speed.
- ◆ A comparison of children's reading on paper versus screen: A meta-analysis by May Irene Furenes, Natalia Kucirkova and Adriana G. Bus (2021). This analysis revealed that:
  - When the only difference between the presentation on paper and on digital media was the content, the result was lower comprehension scores for digital books.
  - When the content presented on digital was enhanced, for example by synchronizing the visualizations with the narration, digital books outperformed paper books.
- ◆ Understanding metacognitive inferiority on screen by exposing cues for depth of processing by Yael Sidi, Maya Shpigelman, Hagar Zalmanov, Rakefet Ackerman (2017). These researchers looked at the impact of time pressure on comprehension:
  - In one experiment, the researchers varied the amount of time that study participants had to read a text. Paper won out when participants had time pressure but did not when the participants were given extra time. In other words, "screen inferiority" became an issue only when time was limited.

As you can see from this list, reading on paper often has advantages—but not always. Just as poor design and layout can damage print's ability to convey content, so can poor digital presentation of material. As the much newer media, designers are learning more about ways that digital media can be enhanced to

explain concepts and story lines more clearly. In addition, the idea that time can be a factor in reading comprehension certainly relates to readers' familiarity with print. What is a bit surprising, however, is the takeaway from one study shown above that paper-based comprehension has improved since 2000. One might think that digital would have made gains over time.

Here are some examples from some other studies on reading comprehension:

- ◆ **Reading comprehension is better when reading from paper versus screens:** This conclusion comes from a European research study of more than 170,000 participants from nineteen countries. Known as The Evolution of Reading in the Age of Digitisation (E-READ) Initiative, this undertaking drew on the results of 54 studies. It was funded by The European Cooperation in Science and Technology (COST). For more details, see [this summary from Intergraf](#).
- ◆ **Children remembered more details from stories read on paper:** This study compared paper books to e-books enhanced with animations, videos, and games. A summary of the research can be found in the November 2013 Scientific American article, [Why the Brain Prefers Paper](#), by Ferris Jabr.
- ◆ **Students read digital formats faster, but at the cost of comprehension:** A March 2016 article in The Journal of Experimental Education entitled [Reading Across Mediums: Effects of Reading Digital and Print Texts on Comprehension and Calibration](#) by Lauren Singer Trakhman and Patricia Alexander noted that while students were able to get the main idea from digital representations of texts, they absorbed fewer details. This implies that students are much better off reading in print for in-depth study such as college or university level courses.

## Personal Preference

Two studies speak to the nature of personal preference regarding print versus digital methods of content distribution.

- ◆ **Learners prefer studying from hard copy:** A 2013 research study entitled [Redefining Reading: The Impact of Digital Communication Media](#) by Naomi Baron (Publications of the Modern Language Association) found that more than 90% of readers across five countries said that they concentrated best when reading in print. Students also said that they were more likely to reread printed material than they would with digital alternatives.

- ◆ **Paper is the preferred medium for longer texts:** An 2018 international study of more than 10,000 respondents called [Academic reading format preferences and behaviors among university students worldwide: A comparative survey analysis](#) (by Diane Mizrahi, Alicia Salaz, Serap Kurbanoglu, and Joumana Boustany) found that a broad majority preferred print for reading longer texts. They felt that they remember the content better and were better able to focus on it.

In addition, paper documents, specifically those that are bound together like books, booklets, magazines, and reports, provide landmarks that researchers say improves the ability to use “mental mapping” as an aid in retention. Improved comprehension and retention are good reasons why readers might prefer paper for school assignments and pleasure reading.

## OPINION

The fact that researchers have developed a term called “screen inferiority” should give print service providers hope. Repeatedly, research studies have shown that comprehension and retention can be improved when reading printed matter. Readers are less likely to be distracted when reading on paper versus an electronic device. Bound paper documents allow readers to use “mental mapping.” And, on top of that, studies have shown that readers simply prefer paper for school assignments and pleasure reading. This is all very good news for paper and print.

The main drawback expressed in some of these studies is that print is more expensive than electronic delivery. So, in many cases, the challenge facing print service providers is in proving the value of print for any given application. What print service providers should keep in mind as they promote print is that the available research strongly supports print's favorability in the reader's ability to focus, their comprehension levels, and (perhaps, most importantly) their preference for paper materials for educational purposes.

Though much of the research relates to educational materials, factors such as focus, comprehension, and preference are equally important in other areas of print—including promotional marketing and transactional documents. This is not to say that print wins in all situations. Our reality is that we live in an electronically-infused world. What we should not overlook, though, is the valuable role that print plays in improved outcomes in many cases.



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### Comments or Questions?

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