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# Print Books and E-Books: How Each Format Plays a Role in Reading Comprehension

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## *Research Question*

What is the effect of reading on screen versus reading in print for an adult's comprehension of the material he/she has read? Does this effect differ with fiction versus nonfiction? What can publishers do to minimize any negative effects?

*Abstract*

This research paper aims to examine the different components of electronic books (e-books) and print books, and seeks to illuminate the ways in which reading retention is affected by each format. Using the data from studies conducted on adult readers, this paper examines how humans process information read from a text; the positive and negative impacts of e-books; whether or not digital natives are affected in the same way by e-readers; and suggestions publishing houses might take considering these findings and the future development of technology.

*Introduction*

The subject of reading is a consistent topic circulating various discussion circles. Questions like “what are you reading” and “how many books have you read this past year” and “have you read \_\_\_\_\_ (fill in the latest best seller)” all suggest that there is a concern with how much time our culture is spending with a book. Advancements in technology have allowed us to store our own little library of books on a small, portable electronic device. It is evident from these technological developments that changes in the practice of reading are occurring, but it is hard to definitively determine where and what is causing the change. Because digital technology and electronic reading methods are relatively new, it has yet to be determined what the long-term sociocultural and psychological effects of these new reading practices might be. While digital texts are still prevalent in the publishing industry, they certainly did not bring the death of print texts as was

once predicted. However, with the trend of e-books on the decline, the question becomes whether or not electronic texts will progress and how might they change the reading habits of society?

The interest in e-readers and e-books has only been prevalent for about ten years, since the launch of the Amazon Kindle in 2007. While initially, “only 4 percent of American adults owned eReaders,” this percentage jumped to 32 percent by 2014.<sup>1</sup> Early models of the e-readers had a sole function: to support e-books. After the debut of the Apple iPad in 2010, later e-reader models began to resemble modern tablets, while still supporting the e-book function. This transition introduced the distraction component in e-reading, a concept we will later explore in depth.

In order to draw conclusions about whether or not electronic texts will change the reading habits of society, we must first acquaint ourselves with what reading is and how do we define e-reading and digital texts? The answer to this can cover a scope of different media. Whether you are browsing the latest news articles, scrolling through your Facebook feed, reading an email on your smart phone, or getting swept away in the latest Neil Gaiman novel on your Kindle, these are all digital texts supported by various electronic platforms. For purposes of this paper, digital texts references pieces of writing longer than a three page news article — in other words, a text that would require a lengthy amount of time to complete, and a deeper level of reading comprehension.

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<sup>1</sup> Naomi Baron, *Words Onscreen: the Fate of Reading in a Digital World* (New York: Oxford University Press, 2015), 8.

<sup>2</sup> Stanislas Dehaene, “Your Brain on Books: Neuroscientist Stanislas Dehaene Explains his Quest to Understand How the Mind

### *What is reading comprehension?*

First we must begin by understanding what reading comprehension is and how our brains process the information that we read. As a reader observes words together they in turn interpret the material to form a greater understanding of the whole. Reading requires memory, perception, and attention, and the way in which a reader interacts with a text influences their overall comprehension of the material. Generally ‘reading comprehension’ is a term that we might associate with schools and children. However, I would argue that it applies to all readers, as it is a process that occurs any time a human interacts with a text.

To break it down at the lowest level, we must understand how the human brain associates letters in the alphabet as shapes which in turn forms words. Neuroscientist Stanislas Dehaene describes this process:

In the case of reading, the shapes of our writing systems have evolved towards a progressive simplification while remaining compatible with the visual coding scheme that is present in all primate brains. A fascinating discovery, made by the American researcher Marc Changizi, is that all of the world's writing systems use the same set of basic shapes, and that these shapes are already a part of the visual system in all primates, because they are also useful for coding natural visual scenes. The monkey brain already contains neurons that preferentially respond to an “alphabet” of shapes including T, L, Y. We merely “recycle” these shapes (and the corresponding part of cortex) and turn them into a cultural code for language.”<sup>2</sup>

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<sup>2</sup> Stanislas Dehaene, “Your Brain on Books: Neuroscientist Stanislas Dehaene Explains his Quest to Understand How the Mind Makes Sense of Written Language,” *Scientific American*, November 17, 2009.

Dehaene later explains that our brains do not rely on the shape of the whole word, but rather breaks down those words into their individual parts at such a fast rate that it merely seems like we are comprehending language as whole words. As our reading skills develop, reading text becomes automatic and it takes less time for us to read a text while still comprehending what we've read. Considering how our brains breakdown language, we can then measure how our eyes work with our brain as we read.

One way to measure reading comprehension and ability is through eye movement studies. Eye movement studies have provided research into the “perceptual and cognitive processes involved in reading.”<sup>3</sup> Many people have the ill-conceived notion that as we read, we absorb the information as stream of consciousness. It has been proven, however, that the acquisition of information is absorbed in a non-linear manner. According to Kristy Roschke and Ralph Radach, “our eyes travel in fast movements, referred to as saccades across a line of text. Saccades are the fastest movements completed by the body.”<sup>4</sup> Saccades move forwards and backwards and recognize the transition from the end of line to the beginning of another. The second method of measuring how we read involves the length of our fixations. The number and length of our eye fixations directly relates to how hard our brain is working to understand the shapes. Fixation is word based and our brains use visual and spatial awareness in tandem. Naturally, longer and more complicated words have a higher probability of fixation.

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<sup>3</sup> Kristy Roschke and Ralph Radach, “Perception, Reading, and Digital Media,” in *The Cognitive Development of Reading and Reading Comprehension*, ed. Carol McDonald Connor (New York: Routledge, 2016), 36.

<sup>4</sup> Ibid.

As of yet, research has been inconclusive as to whether reading efficiency and ability are affected when reading digital texts versus print texts. There is also a lack in research regarding deep reading on print versus electronic format. There are many factors that impact the reading of a digital text, especially factors of distraction. However, we also have to consider that digital texts have not existed as long as print text, which leads into the difference between digital natives and non-natives, and how the reading comprehension differs between each group.

### *Digital natives versus non-digital natives*

Digital native is a term coined by American author Marc Prensky in 2001. The idea behind this concept is that people are defined by the technology of their generation and culture. Digital natives have been born into the digital technological era, while digital immigrants are moving from the analog age into the new digital world. The idea behind digital natives and immigrants is important to consider when reviewing a particular study revolving around book format preference.

A study was conducted in 2014 to determine preference of print versus e-book. The study looked at the distribution of these two platforms among adult readers and found that 57% only read print books, 2% only read e-books, and 14.5% switch between the two formats. The study then looked into the context surrounding the different reader groups to see if ethnicity, income, community, gender, age, education level, and Internet use had any effect on platform preference. Gender, Internet use and community type were fairly even among preference. The

group that stood out the most was age, reflecting that 45% of readers between the ages of 30-49 prefer and read e-books only. The study also revealed much of what is already known about preference of format depending on the reading situation. The high percentage of those that preferred the print book, were readers reading with a child and those that wanted to share their books with other people. The high percentage for those that preferred the e-book were readers who wanted a wide selection to choose from, reading during their commute or travel, and those that wanted to be able to obtain a book quickly.<sup>5</sup>

These findings have somewhat surprising results when thinking about the concept of digital natives. The fact that middle-aged adults prefer reading e-books only suggests that culture is shifting and that digital immigrants are adapting quickly. It is interesting to compare this age group with the question that asked about preference in particular reading situations. It seems evident that while most parents prefer to read print books to their children, the 30-49 age group prefers e-book format. The only thing to conclude here, since 30-49 would be the median age group for parents, is that the e-book preference relates to individual reading, especially considering e-books were preferred during travel or commuting. It is also fascinating that the 18-29 age group data was fairly even in the preference choices (at about 20-25%). What this data shows is that even though young individuals have been born into and are accustomed to the digital era, they aren't regarding print as something of the past.

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<sup>5</sup> Yin Zhang and Sonali Kudva, "E-books versus print books: Readers' Choices and Preferences Across Contexts," *Journal of the Association for Information Science and Technology*, 65: 1695–1706. doi:10.1002/asi.23076



*Advantages of electronic texts*

While the list of disadvantages for e-books can be quite extensive, there are a few positive aspects that should be considered. Convenience is one of the more important advantages in regards to digital reading. That has been the outstanding quality to which e-readers and tablets have been marketed and sold. If you travel for business or you have a commute to and from work, e-readers are far more appealing than lugging around the latest hard-cover edition of a book from your favorite author. Besides the convenience of weight, there are other advantages including adjusting font size or type, increasing brightness for easier readability, highlighting a favorite passage with the swipe of your finger, or following a link to find out more information about a particular topic.

Following convenience is the idea that e-books can have multifunctional qualities. As we will later discover, this too can be a disadvantage, but it truly depends on the reader and the purpose of the e-book. E-books can be designed to have embedded hyperlinks and easy navigation. In the case of textbooks, this can be quite an advantage. The ability to be able to click a link or footnote citation and be taken directly to the source can save time and provides extended learning opportunities. The accessibility of the search function can also help the user easily navigate to a passage or phrase, without the hassle of searching the index or flipping through pages. However, these can also lead to distractions, a negative aspect of e-books that will be covered in the next section.

A third advantage is price. While this is a complicated issue, ultimately for the consumer, e-books will continue to be the more inexpensive option. However, setting a price for e-books and price deflation has been an issue in the publishing industry from the very start. While consumers see price as an advantage (and in some ways it is), the cost of an e-book is far more complicated than the shiny \$1.99 bargain deal. Around 2008, when the Amazon Kindle took hold in the publishing market, most major publishing houses created a policy to set their e-book prices at 20 per cent less than the price of the current print book format (hardback or paperback, whichever was current). Some publishers opted to set the price at the same amount as their print version as they felt that “the primary value of the book was its content, not the particular medium in which it was delivered to the consumer.”<sup>6</sup> Discounting to retailers followed the same method as print books and publishing houses believed Amazon would follow suit. Unexpectedly, Amazon made the executive decision to set all e-book prices at \$9.99. While the company would take a small loss with this discount, they felt that the content would drive the sales of the Kindle devices. The trend that this created was to devalue the “worth” of the book. This trend has continued to occur, especially with bargain companies like BookBub who offer daily deals of e-books priced at \$1.99 or lower. The consumer is being saturated with content and it is marketed in a way that devalues the book as an object. It also forces publishers to set the prices at a lower value in order to compete with the market, because consumers are going to find the cheapest option, generally leading them to Amazon.

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<sup>6</sup> John B. Thompson, *Merchants of Culture* (New York: Plume, 2012), 368.

*What are the negative effects of electronic texts?*

While there are qualities that make the e-book an appealing format, there are also kinks in the system that haven't quite been worked out yet. The sole purpose of the original Kindle (2007 model) was for digital reading. It provided the user with a platform to download multiple books and have them at hand at any point. It was a convenient and advanced new method of reading.

When the Apple iPad was introduced in 2010, all new means of technology was introduced to the world and the tablet began its surge in the electronic economy. In order to keep with the times, the e-reader developed to host other applications beyond just e-books. This new ability to access the internet, play games, and surf social media led to a movement away from actual e-books, which was the original purpose. These distracting elements have continued to progress over time and can be seen as one of the more evident negative effects resulting from e-readers.

The concern the publishing industry had with the rise in tablet use is its multifunction use.

Compared to a single function e-reader, a tablet has the ability to distract the reader with other apps and the use of the Internet. In attempt to compensate, there have been efforts to design e-books with enhanced content. This is counter intuitive since the initial issue is distraction and enriched content will ultimately lead the reader away from the text.

Other qualities of the e-book can also be distracting when it comes to the attention of the reader. Embedded hyperlinks, search functions, and other applications downloaded to the device can gesture the reader away at any moment to lead them far away from the initial text at hand. However, as mentioned in the previous section, these features can also be seen as benefits,

allowing the reader to further explore a piece of literature in a way in which a print book cannot give the same immediate results. The search function is twofold — while it is easy to find a specific passage or phrase, there is the possibility that the reader is comprehending that particular passage out of context of the whole story. If the text has been read before, this is a non-issue. But if the book is something the reader is not familiar with, searching will lead to skimming, which is currently an issue in cultural reading habits.

While distractions are an issue concerning the brain and reading comprehension, the issue of eyestrain and backlit screens can affect the reader's health. While eyestrain developed from backlit electronic devices has been a common side effect, very few studies have shown how light emitting devices affect our sleep. A 2014 study concluded that light-emitting devices (LE) can have a negative effect on our sleep patterns. After extensive testing, the results revealed that the use of a LE device before bed “lengthened sleep latency; delayed the phase of the endogenous circadian pacemaker that drives the timing of daily rhythms of melatonin secretion, sleep propensity, and REM sleep propensity; and impaired morning alertness.”<sup>7</sup> Reading print books or using devices without backlit screens can help to reduce the negative impact. More recently, there are also application and tools that reduce the amount of blue light being emitted from technological devices, which help combat the negative effects for those that prefer using an e-reader before bed.

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<sup>7</sup> Anne-Marie Chang, Daniel Aeschbach, Jeanne Duffy, and Charles Czeisler, “Evening Use of Light-Emitting eReaders Negatively Affects Sleep, Circadian Timing, and Next-Morning Alertness,” *Proceedings of the National Academy of Sciences of the United States of America* 112, no. 4 (2014): 1232–1237. doi:10.1073/pnas.1418490112.

Similar to the health of the reader, there are also issues surrounding the negative impacts e-readers are having on the environment. Contrary to belief, e-readers cause greater impact to the environment than traditional paper books. In 2010, Daniel Goleman and Gregory Norris wrote an enlightening opinion piece in the *New York Times* comparing the environmental impacts of e-readers versus print books. While some of the data may have changed due to advances in technology since the time the piece was written, their findings still provide food for thought in regards to digital devices. After gathering data openly available to the public, the writers concluded that “With respect to fossil fuels, water use and mineral consumption, the impact of one e-reader payback equals roughly 40 to 50 books. When it comes to global warming, though, it’s 100 books;”<sup>8</sup> Even such, trying to establish the exact number of books you need to read to justify using an e-reader can also be arbitrary since there are other factors that come into play like how long each book it, how fast you read each book and, whether or not you finish every single one. We must also consider other factors like reselling books back to a used bookstore or renting books from a library, both of which can significantly reduce the amount of greenhouse emission for that particular book.

Less health related, but equally important is that the physicality of reading a book on a digital platform is removed. E-books are handled differently in the way they are touched, carried, and navigated. According to Anne Mangen, “Studies in experimental psychology and neuroscience show that object manipulation provides spatial information which is crucial for

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<sup>8</sup> Daniel Goleman and Gregory Norris, “How Green is my iPad?” *The New York Times*, April 4, 2010.

building coherent mental representations of the manipulated object.”<sup>9</sup> While navigation helps the reader move from one area to the next (searching for words or phrases, links in table of contents, etc.), there is a lack of spatial awareness. The single page display does not situate the reader within the greater whole of the text. Studies have also shown that readers find issues with the ability to “borrow the books, compatibility issues, and annotation abilities”<sup>10</sup> Digital skeptics have always found flaws with the e-book format. There are certain qualities of print books that cannot be replicated digitally and drive some readers away from adapting to the new technology. Beyond being considered a work of art in its physicality and design, it is user friendly, does not cause substantial eye strain, doesn’t break if you drop it or run out of battery life, and can be seen as a social interaction as it can be shared borrowed, and displayed on a shelf.

*Fiction versus nonfiction books and reading methods:*

After reviewing the positive and negative impacts of e-readers, it is important to consider whether or not the type of text we are reading has an impact on our comprehension and memory. Unfortunately, as much of the research regarding e-books versus print books is still relatively new, there isn’t much data to suggest whether or not the type of book (fiction or non-fiction) factors in to retention rates. The question therefore becomes less about the type of book we are reading and more about how the Internet and technology have changed our reading

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<sup>9</sup> Anne Mangen and Adriaan van der Weel, “The Evolution of Reading in the Age of Digitisation: an Integrative Framework for Reading Research,” *Literacy*, 50: 116–124. doi: 10.1111/lit.12086.

<sup>10</sup> Yin Zhang and Sonali Kudva, “E-books versus print books: Readers’ Choices and Preferences Across Contexts,”

methods. To emphasize the idea of slow reading, Naomi Baron refers to Friedrich Nietzsche's *Daybreak*. Nietzsche suggests that it "is more necessary than ever today, by precisely this means does it entice and enchant us the most, in the midst of an age of "work," that is to say, of hurry, of indecent and perspiring haste, which wants to "get everything done" at once, including every old or new book."<sup>11</sup> However, the idea behind slow reading is subjective to the type of text being evaluated. Slow reading works well for novels and poetry. It works less well for how-to manuals or reference works (like the dictionary or encyclopedia). Ironically, in the early days of technology it was harder to read faster on a computer screen because of the adjustments your eyes needed to make against the computer light and typefaces.

Also, the oversaturation of content and the portable digital devices entice us to skim and get the gist of the content rather than spend time deep reading the whole text. Therefore, as reading and writing coexist, the way we write is changing to adapt to this mode of reading. Some researchers believe that reading is influenced by culture and the way in which we read has changed throughout history. The developments in digital format reading are evolving our reading practices. While the concept of deep reading is still very much a norm in the educational field, outside of this sector, readers are moving away from this method.<sup>12</sup> What does this mean for our established reading skills? If we are moving away from deep reading and adapting to a

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<sup>11</sup> Baron, *Words Onscreen: the Fate of Reading in a Digital World*, 102.

<sup>12</sup> Anne Mangen and Adriaan van der Weel, "The Evolution of Reading in the Age of Digitisation: an Integrative Framework for Reading Research,"

saturated reading market, then the publishing industry must consider how their business models will adapt to this change.

*How can publishers change their business model to reflect the change in technology?*

Considering the constant development of technology, and the fact that print is not dead, we must ask how should publishing houses reshape their business models to reflect the current cultural reading trends?

As has been previously stated, e-books generally have a longer list of disadvantages, and yet, people are still dedicated to using their e-readers and read e-books. If this the case, then we may need to ask why we are attempting to make electronic texts resemble print texts? There is room for growth in the area of e-books. They certainly did not take over the publishing industry as was once predicted in the mid-2000s, but they also haven't completely disappeared. One route publishers might think about is focusing on the benefits of electronic texts and how they can transform the reading experience to be more interactive and informative. A model that worked well was the original Pottermore website. While this site was not an e-book in format, the creators had a strong foundation in how books can be interactive without being distracting. The original site allowed users to listen as the story was being read, while at the same time the user had the option to use their mouse to interact with the illustrations on the page. There was a way in which this was less distracting because the interactions only led the reader deeper into the text and provided a new environment in which the book could be absorbed and remembered. The



site has since changed, but this type of technological practice has the potential to drive society to move farther away from television industry and back to spending more time reading books.

Alternatively, if publishers are not going to take advantage of technology, then we need to revert back to single-purpose e-readers. Publishing houses have less control over this option, as they are not the creators of the e-reader device. However, they do have the option to make their e-books less interactive, resembling some of the technological disadvantages of a print book, but on a digital screen.

Then we must ask how publishers might compensate for the convenience quality of an e-reader for a print text? The purpose of hardcover first editions is to make more money before the second edition soft-cover print run. It is also a way for publishers to earn money while observing whether or not a book is going to do well. Considering small publishers don't have much of an option in terms of a hard-copy print run, let's look at the bigger publishers who have more means for experimenting. Could a publisher turn a profit if they only sold soft-cover and e-books? If we consider convenience, the sales have the potential for increase because paperback is easier to travel with and there is flexibility in e-book pricing, especially if a particular book is in demand. Unfortunately, this may be an idea of grandeur due to bargain companies like BookBub, which devalue the book and make it seem that e-books should be the cheapest monetary option. However, this circles back to convenience, because an e-book offers instant gratification, and if a book is in demand, the consumer will pay the cost to have the instant delivery. Also, the enjoyment of an electronic text might persuade the reader to go and buy the

print version, suggesting that publishers should potentially consider an e-book first business model when publishing a new book.

Some other questions that publishers should consider as technology progresses is how they might change their business model to decrease carbon footprint and environmental impact and how might they format e-books to suggest to readers that slow reading methods should be implemented? Both of these questions have caveats as 1) publishers can't necessarily control the production processes for e-readers and 2) as we have seen earlier, reading habits may be changing and developing to reflect the oversaturation of information in society. Regardless, there are other ways publishers can reduce their carbon footprint through choice of paper and ink. Ultimately, the best practice for all publishing businesses is to stay informed about developments in technology and changes in societal habits.

### *Conclusion*

What is to gain from all of this research? In sum, print is not dead (nor dying), e-books have not dominated the market, and the way in which the human brain comprehends and absorbs information has not, in theory, changed. What has changed is the way in which information is presented to us. It is evident that reading habits differ between a print text and electronic text, and that there are negative effects when using an e-reader, but regardless, reading is still a prevalent activity. While preference of print books still remains strong, we cannot foresee what the future holds, especially in the technological industry. There may come a day when print

becomes obsolete, but until then, publishers should learn to be innovative with the technology at hand and should remember that adaptation is key.

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