Reading on Paper and Reading on Screen: The State of Research

Lettura cartacea e digitale. Lo stato della ricerca

Enrico Meglioli

Abstract

Forms of reading have changed many times over the centuries. Today, after the rise of the Internet and with the widespread diffusion of increasingly more affordable and sophisticated digital technologies, we are experiencing a new, radical change in the way we produce and consume written texts, which have in large part moved from the 'physical' world of paper to the 'virtual' world of digital screens. When the new digital technologies first appeared, the benefits they provided in terms of quantity and quality of information they conveyed in written, visual, audio, and video format spurred many policymakers and leaders in the fields of education and publishing to encourage a complete shift from the paper medium to the digital one. This choice, however, largely underestimated the impact that the reading medium has on the readers' cognitive behaviours and even neurological structures. New studies have started to shed light on the different mechanisms underlying reading on paper and reading on screen, and their specific features. This paper aims at offering a review of the main lines of research concerning the differences between reading on paper and on screen, and what recommendations can be drawn for teachers and all those involved in the literacy education of the new generations, but also for contemporary readers, who have now the opportunity to access more information and stories and in more formats than ever, but can be disoriented by the variety of reading media, and uncertain about how to take the best out of it. Three will be the main focuses of the review: research interested in showing the different impacts of the reading media at the neurological level; research on the physical and haptic differences between reading on paper and reading on screen; and the results of some of the more comprehensive studies on the impacts of the reading media

on comprehension and learning, especially for the young generations of readers.

Keywords: Reading on paper; reading on screen; digital reading; reading media differences; reading comprehension.

Le modalità di lettura sono cambiate molte volte nel corso dei secoli. Oggi, dopo l'avvento di Internet e la capillare diffusione di tecnologie digitali sempre più economiche e sofisticate, stiamo assistendo a un nuovo, radicale cambiamento nel modo in cui produciamo e consumiamo testi scritti, i quali sono in gran parte migrati dal mondo 'fisico' della carta a quello 'virtuale' degli schermi digitali. Quando le nuove tecnologie digitali sono apparse per la prima volta, i benefici apportati in termini di quantità e qualità delle informazioni trasmesse spinsero molti legislatori e dirigenti nei settori dell'istruzione e dell'editoria a incoraggiare una radicale transizione dal mezzo cartaceo a quello digitale. Tale scelta, tuttavia, ha sottovalutato l'impatto che il supporto di lettura ha sui processi cognitivi e sulle strutture neurali dei lettori. Negli ultimi decenni, nuovi studi hanno cominciato a fare luce sui differenti meccanismi alla base della lettura su carta e digitale, nonché sulle rispettive caratteristiche. Il presente contributo si propone di offrire una revisione delle principali linee di ricerca sulle differenze tra lettura cartacea e digitale, nonché delle raccomandazioni che si possono trarre per gli insegnanti e tutti coloro che sono coinvolti nell'istruzione delle nuove generazioni, ma anche per i lettori contemporanei, che hanno oggi l'opportunità di accedere a più informazioni e in più formati che mai, ma che possono rimanere disorientati di fronte a tale varietà. Tre saranno i focus principali dell'analisi: la ricerca volta a mostrare i differenti impatti del mezzo di lettura sul cervello; la ricerca sulle differenze aptiche tra la lettura su carta e la lettura su schermo; e i risultati di alcuni degli studi più esaurienti sui diversi contributi del mezzo di lettura per l'apprendimento.

Parole chiave: Lettura su carta; lettura su schermo; lettura digitale; differenze tra mezzi di lettura; comprensione del testo.

Introduction

At the beginning of the third millennium, with the widespread diffusion of increasingly affordable personal computers and the appearance of new revolutionary devices such as the smartphone and the e-book reader, many proclaimed the imminent death of the 'physical', printed book[1]. Two decades and a half later, the situation looks more nuanced than expected. As international statistics show, the printed book is still an important element of the cultural and mediatic diet, albeit with significant differences between sectors and genres. While, in fact, academic journals have largely moved online because of the ease of accessibility and the necessity to keep pace with the rapid progress in every fields of the research, and newspapers are following a similar route[2], printed books still have by far the largest share in the trade category in many countries. As reported by the Association of American Publishers, for example, in the U.S., in September 2024, of an estimated $911.5 million revenue, 43.9% derived from hardback book sales and 28.9% from paperback book sales, while e-books accounted for 9.9% and digital audio for 9.8% of the sales[3]. Data from Statista.com, on the other hand, offer an insightful picture of the preferences regarding reading medium at the international level: in 2023, China was the only one of the countries taken into consideration – alongside the U.S., Japan, the U.K., Australia, Spain, South Korea, Germany, India, and France – where people who had bought a printed book in the previous year were less than the people who had bought an e-book: 24% and 27%, respectively[4]. It is increasingly clear, then, that different reading media can and are coexisting in contemporary societies, where readers are presented

1 John B. Thompson, *Book Wars: The Digital Revolution in Publishing*, Cambridge: Polity Press, 2002.

2 Milan Frederik Klus - Alexander Dilger, *Success Factors of Academic Journals in the Digital Age*, «Business Research», 13 (2020), pp. 1115-1143, DOI: 10.1007/s40685-020-00131-z.

3 Association of American Publishers (AAP), *AAP September 2024 StatShot Report: Overall Publishing Industry Up 2.4% for Month of September, and Up 7.0% Year-To-Date*. 26 November 2024, <https://publishers.org/news/aap-september-2024-statshot-report-overall-publishing-industry-up-2-4-for-month-of-september-and-up-7-0-year-to-date/> (Accessed: 21 February 2025).

4 Anna Fleck, *E-Books vs. Printed Books: E-Books Still No Match for Printed Books*, «Statista.com», 23 April 2024, <https://www.statista.com/chart/24709/e-book-and-printed-book-penetration/> (Accessed: 21 February 2025).

with an unprecedented variety of choice about not only *what*, but also *how* to read.

This broad range of possibilities, however, can lead to some uncertainty and confusion in the moment of choosing the most adequate reading medium, increased by a lack of knowledge about the actual differences between them. Readers' choices, as a matter of fact, are deeply influenced by different actors, each one with their own goals and needs, such as prominent publishing houses that deploy marketing strategies to steer customers' decisions and public institutions and policy makers that implement regulatory and fiscal frameworks more or less favourable to specific reading media. However, as Gino Roncaglia clearly states:

> [...] the medium is not neutral [...]. On the contrary, the characteristics of the medium and, more in general, of the reading tools and material context, represent the horizon within which some forms of textualities and some typologies of reading are possible and more or less easy[5].

The difference between this last 'revolution' in the way we produce and consume written texts – the fourth, according to Roncaglia, after the transitions from orality to writing, from scroll to book, and from handwriting to print[6] – mainly lies in its rapidity and pervasiveness. When the new digital technologies first appeared, in fact, the benefits they provided in terms of quantity and quality of information they conveyed in written, visual, audio, and video format spurred many policy makers and leaders in the fields of education and publishing to encourage a complete shift from the paper medium to the digital one. This choice, however, largely underestimated the impact that the reading medium has on the readers' cognitive behaviours and even neurological structures.

More recently, and urged by the deep changes in society produced by the radical transformations in the way of producing and sharing culture and knowledge, researchers have devoted increasing attention to the

5 My translation from Gino Roncaglia, *La quarta rivoluzione. Sei lezioni sul futuro del libro*, Roma: Laterza, 2010, p. XI. Original text: «[...] il supporto non è neutrale [...]. Al contrario, le caratteristiche del supporto, e più in generale gli strumenti e il contesto materiale della lettura, costituiscono l'orizzonte al cui interno certe forme di testualità e certe tipologie di lettura risultano possibili e più o meno facili».

6 Gino Roncaglia, *La quarta rivoluzione*, *Ivi*, pp. X-XI.

study of the different reading media. Proof of this is the rise in the numbers of academic publications on topics such as 'reading on paper' and 'reading on screen', as reported by scientific databases such as Scopus and Web of Science[7] (Figures 1-4).

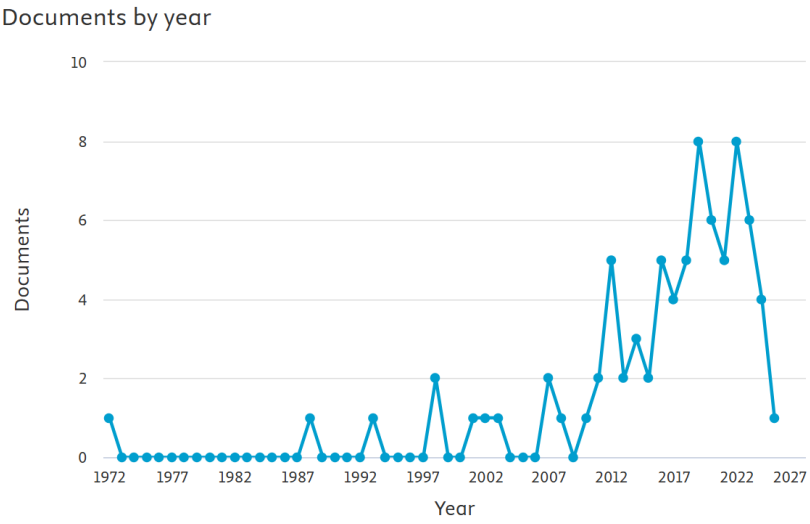

Figure 1. Search for 'Reading on paper' within article title, abstract, and keywords on Scopus (n=78).

7 Elsevier, *Scopus*, <https://www.elsevier.com/products/scopus> (Accessed: 29 March 2025); Clarivate, *Web of Science platform*, <https://clarivate.com/academia-government/scientific-and-academic-research/research-discovery-and-referencing/web-of-science/> (Accessed: 29 March 2025).

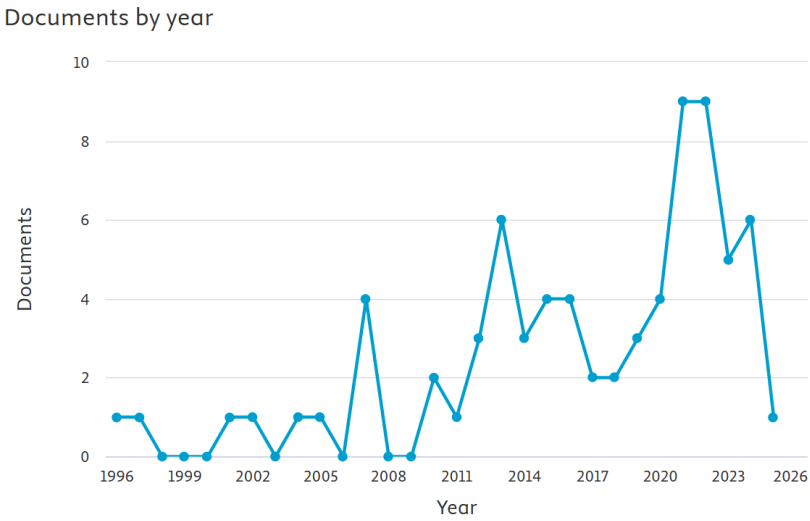

Figure 2. Search for 'Reading on screen' within article title, abstract, and keywords on Scopus (n=74).

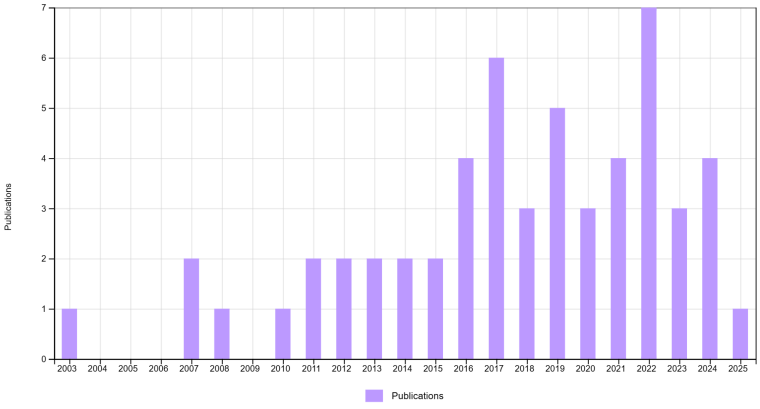

Figure 3. Search for 'Reading on paper' within article title, abstract, and keywords on Web of Science (n=55).

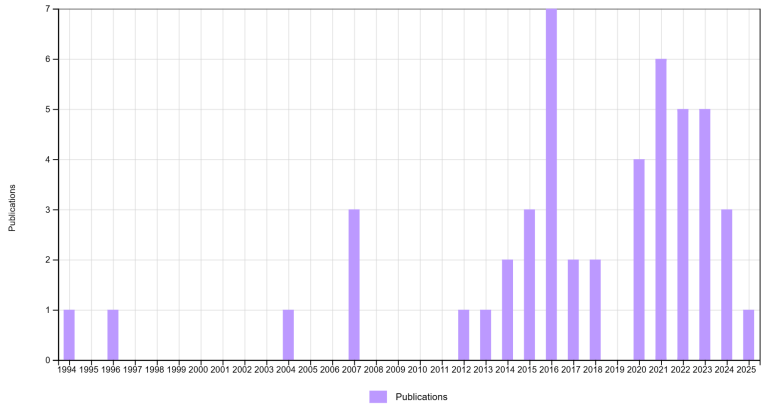

Figure 4. Search for 'Reading on screen' within article title, abstract, and keywords on Web of Science (n=48).

These data, on the other hand, do not show the great variety of directions the research has taken, involving as diverse disciplines as education, information sciences, psychology, linguistics, literary studies, and neuroscience, just to name a few. The variety of perspectives derives from both the complexity and intrinsic transdisciplinarity of the act of reading, and from the number of different factors influencing it. In particular, some of the main factors capable of influencing the reading process – and therefore the choice of the reading medium – are: the *content* of the text, the *context* and the *goal(s)* of the reading act, the *reader*, and the *implications* of such a choice. All these factors and their variables (Figure 5) need to be taken into consideration by readers and institutions who want to make informed choices when approaching the boundless wealth of knowledge, information, stories, emotions, and inspirations contained in books of any sorts.

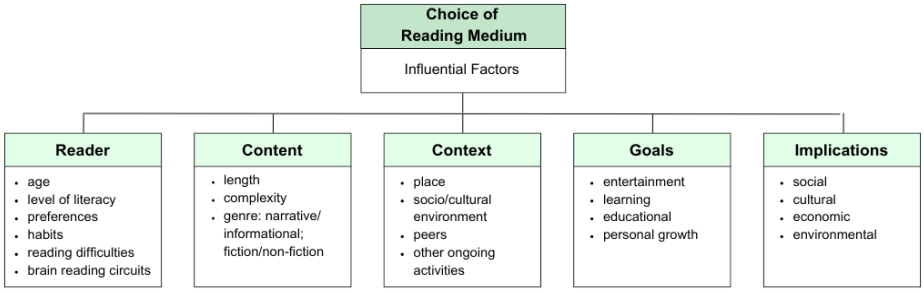

Figure 5. Main factors influencing the choice of the reading medium.

Analysing all the aspects of the reading process and the research dealing with them lies beyond the scope of this paper. Instead, I will present three of the main lines of research that are producing the more insightful results. In a sort of inward-outward movement, I will explore some of the most significant studies on:

1. The impacts of the different reading media at the neurological level.
2. The physical and haptic differences between reading on paper and reading on screen.
3. The impacts of reading and learning choices on the broader socio-cultural and educational contexts, especially on the learning and comprehension performance of the young generations of readers.

These different layers of the research on the reading media show a bidirectional interaction (Figure 6). While the habit of reading on a particular medium may affect the neural reading circuit in a peculiar way, in fact, this altered reading circuit will itself be more prone to certain choices, it will react differently when interacting with alternative media, and it will influence the ways the readers understand texts and learn from them, therefore affecting their role and agency in the socio-cultural world they inhabit, with potential implications on new reading teaching practices, thus closing the 'reading circle'.

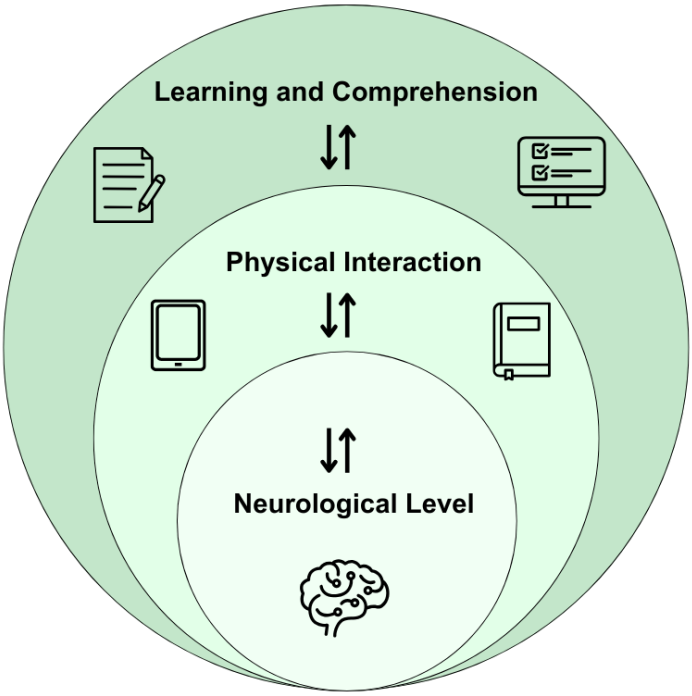

Figure 6. Main lines of research on the effects of the reading media.

Lines of Research

Neurological level

The neural mechanisms underlying our ability to produce written texts and read them are among the most complex and sophisticated carried out by the human brain[8]. Reading, moreover, is not an innate activity of the human species, but it was developed across millennia,

8 See, for ex.: Maryanne Wolf, *Proust and the Squid: The Story and Science of the Reading Brain*, New York: HarperCollins, 2007; Nicole Landi [et al.], *Neurobiological Bases of Reading Comprehension: Insights from Neuroimaging Studies of Word Level and Text Level Processing in Skilled and Impaired Readers*, «Reading & Writing Quarterly», 29 (2013), 2, pp. 145-167, DOI: 10.1080/10573569.2013.758566.

and each reader needs specific and laborious training to acquire it[9]. As noted by Maryanne Wolf, Director of the Centre for Dyslexia, Diverse Learners and Social Justice at UCLA:

> We were never born to read. Human Beings invented reading only a few thousand years ago. And with this invention, we rearranged the very organisation of our brain, which in turn expanded the ways we were able to think, which altered the intellectual evolution of our species. [...]. Our ancestors' invention could come about only because of the human brain's extraordinary ability to make new connections among its existing structures, a process made possible by the brain's ability to be shaped by experience. This plasticity at the heart of the brain's design forms the basis for much of who we are, and who we might become[10].

Reading, therefore, has no single underlying brain structure supporting it. Rather, it is made possible by the capacity of the brain to change and adapt in response to the environment and to explicit training – the so-called 'neuroplasticity'[11] – through the 'recycling' of neural circuits previously employed for different – but usually related – activities[12]. In the case of reading, it has been suggested that neural circuits previously used to detect and recognise objects and signs would have been 'recycled' to allow for the recognition and comprehension of human-made signs – first drawing, then letters[13]. Visual processes, on the other hand, are not the only ones involved in the complex and multifaceted reading activity. As explained by Wolf, five major brain areas activate whenever we read even a single word: Vision, Language, Cognition, Motor, and Affection[14]. Given the intricacy of connections that have to be established among and inside all these different areas, and at the highest levels of coordination and speed – less than half a second for a single word[15] – many scholars, educators, teachers, and readers all

9 Maryanne Wolf, *Proust and the Squid*, cit., p. 19.

10 Eadem, *Proust and the Squid*, *Ivi,* p. 3.

11 Moheb Costandi, *Neuroplasticity*, Cambridge (MA): The MIT Press, 2016.

12 Maryanne Wolf, *Proust and the Squid*, cit.*,* p. 11.

13 Stanislas Dehaene - Laurent Cohen, *Cultural Recycling of Cortical Maps*, «Neuron», 56 (2007), 2, pp. 384-398, DOI: 10.1016/j.neuron.2007.10.004.

14 Maryanne Wolf, *Reader, Come Home*: *The Reading Brain in a Digital World*, New York: HarperCollins, 2019, pp. 21-22.

15 Olaf Hauk [et al.], *The Time-Course of Single-Word Reading: Evidence from Fast Behavioral and Brain Responses*, «Neuroimage», 60 (2012), 2–2, pp. 1462-1477,

over the world have been wondering if and how the diffusion of digital technologies and the related reading habits affect the development of the reading circuit. It has been feared, in fact, that the new way of reading digital texts – characterised by rapid scanning, skimming, and instant reward-seeking typical of the consumption of online news and social media – will be detrimental for the more slowly and laboriously-acquired set of abilities known as 'deep reading'. Coined by Sven Birkerts, who described it as the «slow and meditative possession of a book»[16], the concept of deep reading was later used by many authors to encompass a whole range of cognitive skills that would be employed – and consequently trained – during the careful and sustained reading of long texts, typically identified with the traditional printed book. Among the skills involved in deep reading, in particular, Wolf and Barzillai include «inferential and deductive reasoning, analogical skills, reflection, and insight»[17]. As it can be easily deduced, the development of these abilities have deep repercussions not only on reading comprehension and academic achievement, but in all sorts of everyday activities and interpersonal relationships, especially given the recognised role of immersion into fictional stories for the development of socially advantageous skills such as empathy and Theory of Mind[18]. On the other hand, some authors have criticised the blurriness and broadness of the category of deep reading, and especially its preferential relation with printed books[19]. In the last decades, therefore, studies of different sorts have been carried out to shed light on the issue, and produce reliable results on both the differences and similarities between the reading media in order to understand how to make the best out of them.

With the development of increasingly more accurate and non-invasive techniques of analysis of neural activity, in particular, researchers have

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DOI: 10.1016/j.neuroimage.2012.01.061.

16 Sven Birkerts, *The Gutenberg Elegies: The Fate of Reading in an Electronic Age*, New York: Farrar Straus and Giroux, 2006.

17 Maryanne Wolf - Mirit Barzillai, *The Importance of Deep Reading*, «Educational Leadership», 66 (2009), 6, pp. 32-37.

18 P. Matthijs Bal - Martin Veltkamp, *How Does Fiction Reading Influence Empathy? An Experimental Investigation on the Role of Emotional Transportation*, «PLoS ONE», 8 (2013), 1, pp. e55341, DOI: 10.1371/journal.pone.0055341; David Comer Kidd - Emanuele Castano, *Reading Literary Fiction Improves Theory of Mind*, «Science», 342 (2013), 6156, pp. 377-380, DOI: 10.1126/science.1239918.

19 Robert W. Clower, *Screen Reading and the Creation of New Cognitive Ecologies*, «AI and Society», 34 (2018), 4, pp. 705-720.

been able to use the tools and insights of neuroscience to investigate the reading processes at the deepest biological level. Reading habits, on the other hand, are far from an easy object of research for neuroscientists. While, in fact, it is relatively easy to track the activity of the brain during a single, specifically designed reading activity of a short text, it is far more complicated to analyse all the subtle changes that occur at the neural and cognitive levels during a prolonged, immersive reading session, and even more to assess the results of a sustained reading habit, which is influenced by a broad variety of factors beyond the reading medium and content, as highlighted in Figure 5. Ecological validity, then, is a major challenge when it comes to designing empirical studies in the field that ensure reproducibility and reliability. Many different methodologies have been employed to assess the effects of different types of reading experiences on the human brain, with different groups and different ages.

Particular attention has been devoted to young people and children, given the awareness of the importance of an early and systematic exposition to written culture. Reading, in fact, as anticipated, has a fundamental role in the development of cognitive and affective skills. Moreover – and quite surprisingly – it has been found that reading also activates areas of the brain seemingly unrelated to the 'static' and 'abstract' world of words, such as those involved in motor coordination. In a study carried out in 2017, for example, Hutton and colleagues observed a stronger activation of the cerebellum of 4-year-old girls who had a shared reading experience with their mothers compared to those who didn't, or whose mothers were frequently distracted by other stimuli, such as their smartphones[20]. These results were particularly significant because the cerebellum had traditionally been associated only with motor coordination, precisions, equilibrium, and timing. Hutton and colleagues propose that the cerebellum could play a modulatory role for cognitive skills as well, «facilitating rehearsal, refinement and learning»[21], and accelerating the development of emerging literacy and comprehension abilities[22]. Even if the body remains largely still

20 John S. Hutton [et al.], *Story Time Turbocharger? Child Engagement During Shared Reading and Cerebellar Activation and Connectivity in Preschool-age Children Listening to Stories*, «PLOS One», 2 (2018), 5, p. e0177398, DOI: 10.1371/journal.pone.0177398.

21 Idem, *Story time turbocharger?*, *Ivi*, p. 3.

22 Idem, *Story time turbocharger?, Ibidem*.

while reading or listening to a text, in fact, the brain reproduces the movements, emotions, and thoughts described in the text. This form of 'passive repetition' of the content of the text is made possible by the activation of the so-called 'mirror neurons'[23]. Mirror neurons activate both when the individuals perform an action or feel and emotion, *and* when they see such actions or emotions in other people, or even when they read about them. Mirror neurons, then, would be at the basis of the neural mechanism which allows us to feel, understand, and share the feelings and emotions of other people, real or imaginary, ultimately training the readers' empathic abilities. Empathy, understanding of others, critical analysis, ability to draw analogies and inferences are all superior intellectual and emotional faculties that the deep reading of printed books helps to shape and strengthen, as highlighted by Wolf[24]. The questions then arise: are the same processes supported by digital reading? Will an increasing preponderance of time and attention dedicated to online activities negatively affect not only people's cognitive skills, but also their empathic and social ones?

Horowitz-Kraus and Hutton tried to answer this question by analysing the relationship between the time spent by 8–12-year-old children using screen-based media – including smartphone, tablet, computer, and television – the time spent reading, and the functional connectivity of brain regions supporting reading-related visual, language, and executive cognitive processes[25]. In particular, the authors focused on the connectivity between the left fusiform gyrus – also known as the 'visual word form area', responsible for the recognition of letters and groups of letters – and the other regions of the reading brain circuit. The results of the study showed that children who spent more time reading had higher connectivity between the visual word form area and the other regions devoted to language, visual association, and cognitive control

23 See Giacomo Rizzolatti [et al.], *Premotor Cortex and the Recognition of Motor Actions*, «Cognitive Brain Research», 3 (1996), 2, pp. 131-141, DOI: 10.1016/0926-6410(95)00038-0; Giacomo Rizzolatti - Maddalena Fabbri-Destro - Luigi Cattaneo, *Mirror Neurons and Their Clinical Relevance*, «Nature Clinical Practice. Neurology», 5 (2009), 1, pp. 24-34, DOI: 10.1038/ncpneuro0990.

24 Maryanne Wolf, *Reader, Come Home*, cit., *Letter Three*.

25 Tzipi Horowitz-Kraus - John S. Hutton, *Brain Connectivity in Children Is Increased by the Time They Spend Reading Books and Decreased by the Length of Exposure to Screen-Based Media*, «Acta Paediatrica», 107 (2017), 4, pp. 685-693, DOI: 10.1111/apa.14176.

compared to children who were more exposed to screen-based media, with significant impact on future language and academic outcomes[26].

On the other hand, children are not the only ones affected by the pervasive diffusion of digital devices. A scoping review by Marciano, Carmini, and Morese published in 2021 offers an insightful summary of the results of neuroimaging studies aimed at analysing the neurological effects of time spent in screen-based activities by adolescents[27]. The review highlights, in particular, that screen-based media consumption is related to a less efficient cognitive control system, including parts of the Central Executive Network and of the Default Mode Network (DNM)[28]. The DNM is a still largely mysterious neural network associated with activities like mind-wandering, narrative construction, simulation of future behaviours, and 'self-projection', which is the ability to understand other people's behaviours by projecting into their situations and life-conditions[29]. Online activities, on the other hand, provide strong and rapid neural rewards for the brain, so that an increase in screen time positively correlates with the tendency of seeking short-term gratifications and developing Internet-related addictive behaviours, impulsiveness, and irritability[30].

These results may appear only loosely related to the comparison between reading on paper or on screen. However, it is precisely the 'indirect' influence of other screen and online-related activities that, according to scholars such as Wolf, would represent one of the major challenges to the preservation of the achievements of the paper-based culture at both individual and societal levels[31]. As reading on screen

26 Tzipi Horowitz-Kraus - John S. Hutton, *Brain Connectivity in Children, Ibidem*.

27 Laura Marciano - Anne-Linda Camerini - Rosalba Morese, *The Developing Brain in the Digital Era: A Scoping Review of Structural and Functional Correlates of Screen Time in Adolescence*, «Frontiers in Psychology», 12 (2021), DOI: 10.3389/fpsyg.2021.671817.

28 Idem, *The Developing Brain in the Digital Era*, *Ivi*, p. 8.

29 See, for ex.: Randy L. Buckner - Daniel C. Carroll, *Self-Projection and the Brain*, «Trends in Cognitive Sciences», 11 (2007), 2, pp. 49-57, DOI: 10.1016/j.tics.2006.11.004; Malia F. Mason [et al.], *Wandering Minds: The Default Network and Stimulus-Independent Thought*, «Science», 315 (2007), 5810, pp. 393-395, DOI: 10.1126/science.1131295.

30 Laura Marciano - Anne-Linda Camerini - Rosalba Morese, *The Developing Brain in the Digital Era*, cit., p. 10.

31 Maryanne Wolf, *Reader, Come Home*, cit., *Letter Four*.

and interacting with digital devices largely involve multitasking, short messaging, skimming, scanning, superficial reading, and short attention span, it is highly probable that these habits – if not carefully checked and understood – will be transferred to other reading environments – such as schools and workplaces – where sustained attention and deep reading of texts are preferable[32]. A study by Ward and colleagues, moreover, found that the simple *presence* of smartphones in an experimental setting occupied part of the cognitive resources of their owners, even if they did not use them, impairing their performance on tasks aimed at assessing general attention, memory, and skills; participants whose smartphones had been left in another room, on the other hand, performed significantly better[33].

Wolf's fear, then, is that, as much as the neuroplasticity of the brain allows us to learn the complex processes necessary to read in a deep and intentional way, so the same neuroplasticity could lead the readers of the new digital era to adapt their neural circuits to new pathways that are better suited to the fast skimming of a vast quantity of multimedia contents. In this way, deep reading would be replaced by what, in 1999 – years before the massive diffusion of smartphones, tablets, and e-readers – James Sosnoski called 'hyper reading', characterised by filtering, skimming, less contextualisation, less attention to authorly intention, and focus on graphic elements[34]. A constant habit of hyper-reading would have as an additional consequence a significant reduction of cognitive patience, that is, the «ability to read with focused and sustained attention and delay gratification, while refraining from multitasking or skimming over parts of the text»[35].

Supporting these hypotheses, a meta-analysis by Delgado and colleagues on studies carried out between 2000 and 2017 found that

32 Eadem, *Reader, Come Home*, *Ibidem*.

33 Adrian F. Ward [et al.], *Brain Drain: The Mere Presence of One's Own Smartphone Reduces Available Cognitive Capacity*, «Journal of the Association for Consumer Research», 2 (2017), 2, pp. 140-154.

34 James J. Sosnoski, *Hyper-Readers and Their Reading Engines*, in *Passions, Politics, and 21st Century Technologies*, edited by E. G. Hawisher - C. L. Selfe, Logan, Utah and Urbana, Illinois: Utah State University Press-NCTE, 1999, pp. 161-177.

35 Inge van de Ven - Frank Hakemulder - Anne Mangen, *TL;DR (Too Long; Didn't Read)? Cognitive Patience as a Mode of Reading: Exploring Concentration and Perseverance*, «Scientific Study of Literature», 12 (2023), pp. 68-86, DOI: 10.61645/ssol.176.

readers of printed texts generally perform better on reading comprehension tasks compared to readers of the same texts on screen[36]. This apparent inferiority of the digital text compared to the printed one would derive, according to the authors, from an excess of confidence and superficiality of processing while reading the digital texts caused by the automatic association between reading on screen and other activities typical of the digital environment, such as the use of social networks and Internet browsing – the so-called 'shallowing hypothesis'[37]. Moreover, the differences between digital and paper reading would emerge especially in the presence of moderating elements such as a limited reading time and differences in literary genre. Better results for reading on paper, in fact, were achieved when participants read under a limited time frame and with informative or mixed informative-narrative texts, but not in the case of reading only narrative texts and without time limits[38]. These conditions, the authors conclude, have to be fully appreciated by educators and policy makers when designing activities such as school tasks, exams, and admission tests[39].

Finally, another consequence of the massive digitisation of reading would be what the Kaspersky Lab dubbed 'digital amnesia', that is, «the experience of forgetting information that you trust a digital device to store and remember for you»[40]. Interestingly, the same awareness of the reduction of mnemonic capacities due to the introduction of new, more efficient ways of storing and sharing knowledge troubled the great masters of ancient Greek philosophy, who were experiencing the transition from an oral to a fully written culture. Plato himself, whose written works have so deeply influenced Western thought, included in his dialogue *Phaedrus* (c. 370 B.C.) an admonition by Socrates for his

36 Pablo Delgado [et al.], *Don't Throw Away Your Printed Books: A Meta-Analysis on the Effects of Reading Media on Reading Comprehension*, «Educational Research Review», 25 (2018), pp. 23-38, DOI: 10.1016/j.edurev.2018.09.003.

37 See, for ex.: Nicholas G. Carr, *The Shallows: What the Internet is Doing to Our Brains*, New York: W. W. Norton, 2010; Logan E. Annisette - Kathryine D. Lafreniere, *Social Media, Texting, and Personality: A Test of the Shallowing Hypothesis*, «Personality and Individual Differences», 115 (2017), pp. 154-158, DOI: 10.1016/j.paid.2016.02.043.

38 Pablo Delgado [et al.], *Don't Throw Away Your Printed Books*, cit.

39 Idem, *Don't Throw Away Your Printed Books*, *Ivi*, p. 36.

40 Kaspersky Lab, *The Rise and Impact of Digital Amnesia: Why We Need to Protect What We No Longer Remember*, June 2015, <https://blog.kaspersky.com/files/2015/06/005-Kaspersky-Digital-Amnesia-19.6.15.pdf> (Accessed: 29 March 2025).

contemporaries that they did not trust written words too much, as they would have severely limited memory and the possibility of discovering truth through dialogue and 'by themselves'[41]. Throughout the more than two millennia that followed Plato's warning, many civilizations around the world have moved from a culture exclusively based on orality to one that had the written text as its primary means of transmission and development, while, of course, not abandoning speech and dialogue. What was lost in terms of memory or other cognitive and affective abilities is difficult to say and quantify, given the absence of scientific ways of analysing those crucial moments of transition. Can we expect something similar to happen now that the 'paper culture' is rapidly transforming into a digital one? Can we allow ourselves to 'let things go' without questioning where they are going and who is moving them? On the other hand, one could also legitimately ask: why shouldn't it be possible to develop deep reading abilities by reading on screen? Is there any objective difference between the effects of reading a printed book and reading a digital text? This is what the line of research on the physical and haptic differences between reading media aims at clarifying.

Physical and Haptic Interaction

The mind-body dualism typical of the Cartesian philosophy – according to which the substance of the body and the substance of the mind have completely different natures, and they are only loosely connected through the brain – and the conceptions of 'pure intelligence' detached from the body propounded by cognitive theories such as formalism and computationalism have been increasingly put into question in recent decades[42]. Spurred by milestones works such as Varela, Thompson, and Rosch's book *The Embodied Mind: Cognitive Science and Human Experience* (1991)[43] and Clark and Chalmers' article *The Extended*

41 Plato, *Phaedrus*, trans. by David Gallop, Oxford: Oxford University Press, 1975.

42 See, for ex.: Alex Ball, *The Mind-Body Problem and Cognitive Neuroscience: A Brief History and Outlook*, «Brain Matters», 6 (2023), 1, pp. 15-18; Elham Shirvani - Masoud Shirvani, *Evaluation of the Relation between Cognitive Science and Embodied Cognition*, «World Journal of Neuroscience», 13 (2023), 4, pp. 210-227, DOI: 10.4236/wjns.2023.134014.

43 *The Embodied Mind* (n.d.) *MIT Press*, <https://mitpress.mit.edu/9780262720212/the-embodied-mind/> (Accessed: 27 March 2025).

Mind (1998)[44], and supported by recent neuroscientific studies, new models of cognition have been proposed that hold in higher regard the role of the whole body and its environment in mental processes formation. These new paradigms of cognition can be reunited under the umbrella terms of 'grounded cognition' or '4E cognition' (embodied, embedded, enacted, extended)[45].

Following these paradigms, reading itself cannot be considered as a purely abstract activity limited to the brain. When we read, in fact, a large part of our senses come into play: vision, touch, smell, hearing – the sounds of rustling pages compared to the soft tapping of fingers on glass, for example – and even taste – albeit generally limited to infants. It is therefore essential not to underestimate all the sensorial aspects and material affordances of the reading medium, if a complete picture of its effects on the reader wants to be produced.

In particular, the study of the physical and haptic – from the Greek *haptikos*, meaning 'able to touch'[46] – differences between reading on paper and reading on screen and their effects on how the reader elaborate and understand the content of the text has been one of the main focuses of the work of the Norwegian Reading Centre at the University of Stavanger (Norway)[47]. As highlighted by one of its members, Professor Anne Mangen:

> [...] the transition from print to digital reading makes apparent that reading also entails embodied – physical – engagement with a material substrate (for example, paper; computer and tablet screens)[48].

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44 Andy Clark - David Chalmers, *The Extended Mind*, «Analysis», 58 (1998), 1, pp. 7-19.

45 See, for ex.: Diana Stanciu, *Consciousness, 4E Cognition and Aristotle: A Few Conceptual and Historical Aspects*, «Frontiers in Computational Neuroscience», 17 (2023), DOI: 10.3389/fncom.2023.1204602; James Carney, *Thinking avant la lettre: A Review of 4E Cognition*, «Evolutionary Studies in Imaginative Culture», 4 (2020), 1, pp. 77-90, DOI: 10.26613/esic.4.1.172.

46 Anne Mangen, *What Hands May Tell Us about Reading and Writing*, «Educational Theory», 66 (2016), 4, pp. 457-477: 457-458, DOI: 10.1111/edth.12183.

47 Norwegian Reading Centre, <https://www.uis.no/en/norwegian_reading_centre> (Accessed: 28 March 2025).

48 Anne Mangen, *What Hands May Tell Us about Reading and Writing*, cit., pp. 457-458.

The specific haptic and kinaesthetic features, the sensorimotor contingencies, and the ergonomic affordances of a reading technology, therefore, would deeply – albeit often subconsciously – affect all the cognitive processes related to reading[49].

Evidence of this came from a 2013 study by Mangen, Walgermo, and Brønnick[50]. In the study, 72 tenth graders (15-16 years old) were divided into two groups: one group read one narrative and one expository text on screen; the other group read the same texts on paper. The texts presented on screen had no hypertext features, in order to compare 'pure', linear reading on screen with reading the same text on paper. After reading each text, the participants were asked to answer some questions aimed at assessing three categories of abilities related to reading comprehension: access and retrieve, integrate and interpret, and reflect and evaluate[51]. Similarly to what observed by Delgato and colleagues in the meta-analysis cited above, the results of the study showed that students who read the texts on paper performed better on the reading comprehension test compared to those who read them on screen. To explain these results, the authors suggested that the differences in navigation modality between the reading media had a significant impact on comprehension. In particular, it has been proposed that scrolling has a negative effect on comprehension, as the physical fixity provided by the paper text, both visual and tactile, would support the «reader's construction of the spatial representation of the text by providing unequivocal and fixed spatial cues for text memory and recall»[52]. The text on screen, on the other hand, allowing the reader to read only one page at a time, would make the creation of a mental map of the text more difficult[53].

Further extending this line of research, in a study carried out by Mangen, Olivier, and Velay in 2019, fifty participants (24 years old) were asked to read a long mystery story on Kindle or paper. This time,

49 Eadem, *What Hands May Tell Us about Reading and Writing, Ivi*, p. 462.

50 Anne Mangen - Bente R. Walgermo - Kolbjørn Brønnick, *Reading Linear Texts on Paper Versus Computer Screen: Effects on Reading Comprehension*, «International Journal of Educational Research», 58 (2013), pp. 61-68, DOI: 10.1016/j.ijer.2012.12.002.

51 Anne Mangen - Bente R. Walgermo - Kolbjørn Brønnick, *Reading Linear Texts on Paper Versus Computer Screen*, *Ibidem*.

52 Idem, *Reading Linear Texts on Paper Versus Computer Screen*, *Ivi*, p. 66.

53 Idem, *Reading Linear Texts on Paper Versus Computer Screen*, *Ibidem*.

the results of various tests found that readers performed similarly in terms of basic comprehension, engagement and transportation into the story, and word and sentence recognition, independently of the media. On the other hand, participants who read the printed book appeared to be better capable of localising events in the text and reconstructing the plot, creating a chronological representation of it[54]. The authors suggest that these differences between the two groups depend on the different sensorimotor cues offered by the printed book and by the digital device. In particular, following and expanding the conclusions by Hou, Rashid, and Min Lee – who compared comprehension scores after reading a comic book on paper or iPad[55] – Mangen and colleagues hypothesised that the lack of visual anchors showing the progression through the text – such as the visual perception of how much of the text has been read and how much is left – would hinder the capacity of the reader to easily locate events and information in the text[56]. This 'weakness' of the digital text, Hou and colleagues propose, can be overcome by a design that reproduces the book structure and offers the readers visual aids to construct a cognitive map of the text[57]. A second mechanism that could explain the so-called 'screen inferiority'[58] in relation to events localisation and plot reconstruction is the sensorimotor and material engagement. This would differ significantly between readers of the digital text and readers of the printed book, such as in the way the reader interacts with the medium and moves through the text flipping the printed pages or scrolling and clicking on the screen. While Hou and colleagues did not collect enough evidence to support the hypothesis that medium materiality influences text processing, Mangen and colleagues suggest that sensorimotor cues and visual anchors may complement each other in

54 Anne Mangen - Gerard Olivier - Jean-Luc Velay, *Comparing Comprehension of a Long Text Read in Print Book and on Kindle: Where in the Text and When in the Story?*, «Frontiers in Psychology», 10 (2019), p. 6, DOI: 10.3389/fpsyg.2019.00038.

55 Jinghui Hou - Justin Rashid - Kwan Min Lee, *Cognitive Map or Medium Materiality? Reading on Paper and Screen*, «Computers in Human Behavior», 67 (2017), pp. 84-94, DOI: 10.1016/j.chb.2016.10.014.

56 Anne Mangen - Gerard Olivier - Jean-Luc Velay, *Comparing Comprehension of a Long Text Read in Print Book and on Kindle*, cit., p. 8.

57 Jinghui Hou - Justin Rashid - Kwan Min Lee, *Cognitive Map or Medium Materiality?*, cit., p. 93.

58 Pablo Delgado [et al.], *Don't Throw Away Your Printed Books*, cit., p. 34.

explaining the difficulties often showed by the readers of digital texts, depending on the characteristics of the text and medium employed[59].

As it can be expected, differences between paper and screen also directly impact education activities and results. In a 2020 study, for example, Støle, Mangen, and Schwippert analysed the results of reading comprehension tests taken by 10-year-old Norwegian children either on paper or on screen[60]. The authors found that almost a third of the students (373 out of 1139) performed better on the paper test. In particular, girls with the highest reading achievement levels were the most negatively affected by the digital test option[61]. Many are the possible explanations of these results taken into consideration by the authors. The hypothesis that lower scores in the digital test can derive from lack of digital skills and experience was deemed unsuitable, due to the high level of access to digital devices and the Internet of Norwegian children[62]. More relevant could have been the effects of time limit and of scrolling on the children's abilities to keep track of the reading rate and construct an accurate mental representation of the text structure. Scrolling, in fact, would pose an additional burden to the reader's working memory and cognitive efforts to navigate the text[63]. As a consequence, reading time would increase and inferential comprehension efficiency would decrease when children read a text on screen compared to reading on paper[64]. Moreover, being inferentiality, a higher-order reading process

59 Anne Mangen - Gérard Olivier - Jean-Luc Velay, *Comparing Comprehension of a Long Text Read in Print Book and on Kindle*, cit., p. 8.

60 Hildegunn Støle - Anne Mangen - Knut Schwippert, *Assessing Children's Reading Comprehension on Paper and Screen: A Mode-effect Study*, «Computers & Education», 151 (2020), DOI: 10.1016/j.compedu.2020.103861.

61 Idem, *Assessing Children's Reading Comprehension on Paper and Screen, Ibidem*.

62 Niahm Ní Bhroin - Middelboe M. Rehder, *Digital Natives or Naïve Experts? Exploring How Norwegian Children (Aged 9-15) Understand the Internet. EU Kids Online 2018,* London: LSE, November 2018, <https://www.lse.ac.uk/media-and-communications/assets/documents/research/eu-kids-online/reports/ norway-report.pdf> (Accessed: 29 March 2025).

63 Christopher A. Sanchez - Jennifer Wiley, *To Scroll or Not to Scroll: Scrolling, Working Memory Capacity, and Comprehending Complex Texts*, «Human Factors», 51 (2009), 5, pp. 730-738, DOI: 10.1177/0018720809352788.

64 Matthew A. Kerr - Sonya E. Symons, *Computerized Presentation of Text: Effects on Children's Reading of Informational Material*, «Reading and Writing», 19 (2006), 1, pp. 1-19, DOI: 10.1007/s11145-003-8128-y.

particularly developed in top-performing readers, this group would be more negatively affected while reading on screen, as observed by Støle, Mangen, and Schwippert[65]. Finally, another major factor influencing the differences on reading performance would be the phenomenon – described above – according to which reading strategies and habits typical of the digital environment would be employed also where deep reading processes are more needed. Therefore, the authors conclude, it is important to support the children's understanding of the different reading strategies for screen and paper and how to adequately employ them, while policymakers and educators should be aware of these differences and their effects on reading comprehension, recognising both the potential of the digital technologies in education and the unique contribution of printed books on the development of linguistic, cognitive, and affective skills[66].

After highlighting many of the challenges posed by reading on screen, and especially the dangers of a superficial choice of the reading medium and of reading strategies, it is important to underline also the role of digital technologies in strengthening reading habits and achieving learning goals. Moreover, some physical characteristics of the printed book can represent limitations that the digital text would overcome, such as text size, brightness, spacing – which particularly affect people with dyslexia – and weight of the book, that digital devices allow to customize according to each reader's needs.

In particular, with the emergence of touch screen tablets and applications offering ever-more sophisticated multimedia texts where audio, video, animations, and written words combine and offer themselves to the interaction with the reader, it became clear that a careful balance is needed between the narrative content of the story and the multimedia and interactive apparatus in order to ensure transportation in the story and its comprehension[67]. The reading experience with digital and interactive books, in fact, can be more game-like and less favourable

65 Hildegunn Støle - Anne Mangen - Knut Schwippert, *Assessing Children's Reading Comprehension on Paper and Screen*, cit., p. 10.

66 Idem, *Assessing Children's Reading Comprehension on Paper and Screen*, *Ibidem*.

67 Mirit Barzillai - Jennifer M. Thomson - Anne Mangen, *The Influence of E-Books on Language and Literacy Development*, in *Education and New Technologies*, edited by K. Sheehy and A. Holliman, London: Routledge, 2017.

to immersion and identification[68]. On the other hand, well-designed e-books can be a significant help for fostering literacy skills such as vocabulary, thanks to the possibility of accessing the Internet, exploring definitions, examples, hyperlink, and additional material, both textual and multimedia, as well as performing activities such as multiple-choice questions, especially for children with reading difficulties[69]. In fact, some studies did not find any significant differences between children's learning outcomes after reading a carefully designed multimedia story and after sharing stories on printed books with an adult[70]. Moreover, digital books enriched with multimedia content can support children with learning difficulties caused by environmental distractions, thanks to the multi-sensory engagement provided[71].

The capacity of digital books to flexibly adapt to the reading and learning goals of the readers, both in terms of hardware and software, represent their main strength and resource, which is still largely untapped. To do so in the best way for the development of readers, both young and adult, requires careful attention to each reader's skills and needs, to the characteristics of the text and the medium, as well as involvement of educators, caregivers, and readers themselves in supporting interdisciplinary research in the field.

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68 Idem, *The Influence of E-Books on Language and Literacy Development*, in *Education and New Technologies*, *Ivi*, p. 37.

69 See, for ex.: Daisy J. H. Smeets - Adriana G. Bus, *The Interactive Animated E-Book as a Word Learning Device for Kindergartners*, «Applied Psycholinguistics», 36 (2015), 4, pp. 899-920, DOI: 10.1017/S0142716413000556; Daisy J. H. Smeets - Adriana G. Bus, *Interactive Electronic Storybooks for Kindergartners to Promote Vocabulary Growth*, «Journal of Experimental Child Psychology», 112 (2012), 1, pp. 36-55, DOI: 10.1016/j.jecp.2011.12.003.

70 Zsofia K. Takacs - Elise K. Swart - Adriana G. Bus, *Can the Computer Replace the Adult for Storybook Reading? A Meta-Analysis on the Effects of Multimedia Stories as Compared to Sharing Print Stories with an Adult*, «Frontiers in Psychology», 5 (2014), DOI: 10.3389/fpsyg.2014.01366.

71 Adina Shamir - Ofra Korat - Inessa Shlafer, *The Effect of Activity with E-Book on Vocabulary and Story Comprehension: A Comparison Between Kindergarteners at Risk of Learning Disabilities and Typically Developing Kindergarteners*, «European Journal of Special Needs Education», 26 (2011), 3, pp. 311-322, DOI: 10.1080/08856257.2011.593824.

Learning and Comprehension Performance

Finally, research has focused not only on experiments carried out in controlled environments, but also on the analysis of the results of tests taken by pupils and students all over the world to assess their skills and knowledge in different disciplines. Abundant data, in particular, come from international programmes such as the PISA (Programme for International Student Assessment) – run by the Organisation for Economic Co-operation and Development (OECD) to assess 15-year-old pupils' proficiency in reading, mathematics, and science[72] – and the PIRLS (Progress in International Reading Literacy Study) – run by the International Association for the Evaluation of Educational Achievement (IEA) to assess 9-10-year-old pupils' reading abilities[73]. These data can be extremely helpful to understand and evaluate the impact of the growing digitization of school curricula. However, careful examination is needed to highlight possible confounding factors and national and local differences, as well as flaws and biases in the tests themselves. In her *How We Read Now: Strategic Choices for Print, Screen, & Audio* (2021), Naomi Baron, Prof Emerita of World Languages and Cultures at American University, undertook the endeavour, compiling a comprehensive review and reflection on what the reading and learning performance of pupils and students can teach us about the changes in reading behaviours and media, not limited to paper and screen, but including video and audio materials[74]. Many are the insights collected by Baron. I will now summarise some of the most significant.

First, research has shown that medium preferences are not directly correlated to reading performance: in recent years, in fact, students have been showing an increasing preference for digital texts, but their scores on in-depth comprehension continue to be higher when reading on paper[75]. If, at the beginning of the digital era, readers – and especially university students – believed to perform better when reading printed texts, contemporary students – constantly immersed in digital

72 OECD, Programme for International Student Assessment (PISA), n.d., <https://www.oecd.org/en/about/programmes/pisa.html> (Accessed: 28 March 2025).

73 IEA, *PIRLS: Progress in International Reading Literacy Study*, n.d., <https://www.iea.nl/studies/iea/pirls> (Accessed: 28 March 2025).

74 Naomi S. Baron, *How We Read Now: Strategic Choices for Print, Screen, and Audio*, New York: Oxford University Press, 2021.

75 Naomi S. Baron, *How We Read Now*, *Ivi*, ch. 4.

interactions and required to do assignments largely in digital format – seem to overestimate their performance when reading digital texts[76].

Text genres, on the other hand, seem to play a crucial role, as no major differences in comprehension scores after reading narrative texts on paper or on screen have been observed, while comprehension is usually better after reading informational texts on paper[77].

Other factors that deeply influence reading choices, moreover, are unrelated to the content of the text and the characteristics of the reader: as highlighted by Baron, in fact, the prices of paper textbooks have massively increased in the last decades: in the U.S., for example, paper textbook prices increased by 1,041% between 1977 and 2015[78]. As it can be easily deduced, such market-related dynamics have deep and long-lasting impacts on readers' habits. Similarly impactful are the choices of major publishing companies: Pearson, for example – the world's largest textbook publisher – announced in 2019 a 'digital first' policy, by which new books will be first published in digital format and the print editions will be updated less frequently[79].

When it comes to the international assessments of reading and comprehension skills, the results seem to point at a high correlation between print and digital reading results, as illustrated by the 2012 PISA assessment of 15-year-old pupils. However, it is worth noticing that the print and digital versions of the tests had different structures, with the first including individual linear texts, while the second multiple texts, and different countries performed differently, possibly showing different levels in computer and digital literacy. Good reading skills on one medium, on the other hand, does not seem to necessarily involve lack of abilities on other media, and digital skills can be transferable to non-digital environments, as proved by Salmerón and colleagues, but only after adequate training[80].

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76 Eadem, *How We Read Now*, *Ibidem*.

77 Eadem, *How We Read Now*, *Ibidem*.

78 Eadem, *How We Read Now*, *Ivi*, ch. 2.

79 Eadem, *How We Read Now, Ibidem;* Bill Rosenblatt, *Pearson's Digital-First Strategy Will Change How Students Get Textbooks*, «Forbes», 20 July 2019, <https://www.forbes.com/sites/billrosenblatt/2019/07/20/pearsons-digital-first-strategy-will-change-how -students-get-textbooks/> (Accessed: 28 March 2025).

80 Patrícia Dinis da Costa - Luísa Araújo, *Digital Reading in PISA 2012 and ICT Uses: How do VET and General Education Students Perform?*, *EUR 28291 EN*, 2016, DOI:10.2791/900596; Ladislao Salmerón - Arantxa García - Eduardo

Moving to the analysis of the results of school tests according to the medium, Baron notices that students who already have lower reading scores and learning difficulties obtain more negative results on digital tests, while those with limited working memory are particularly challenged by tasks involving multiple online documents, thus increasing their vulnerability compared to other students[81]. These results need to be taken in consideration when designing assessment procedures in school, as well as international assessment programmes. Significantly, in 2026, PIRLS tests are expected to be entirely digital, with the rationale of keeping pace «with an increasing worldwide reliance on digital communication and assessment»[82], and PISA tests have already transitioned to a computer-based format since 2015[83]. In both cases, however, as noted by Baron, the role of narrative literacy is very limited, which appears to be a serious deficiency, given the importance of reading fiction in vocabulary and comprehension achievements, as well as in general reading and learning enjoyment[84]. We may wonder what the consequences of the conclusions drawn by policymakers from the results of those tests will be, if the nuanced array of features of the different reading media on different people will not be included in the assessment anymore.

Conclusion

Clearly, the state of the research in the field of the reading media and strategies and their effects on individuals and societies is anything but a 'state'. With technology evolving at breakneck speeds – it would be a matter of another paper to ponder if Roncaglia would have considered AI-generated books a 'fifth revolution' or the endgame for book culture – and ever-changing digital habits, it is no surprise that little of what was considered a given in research yesterday can hold its ground today. However, the efforts of many scholars – as well as all the participants

Vidal-Abarca, *The Development of Adolescents' Comprehension-Based Internet Reading Skills*, «Learning and Individual Differences», 61 (2018), pp. 31-39, DOI: 10.1016/j.lindif.2017.11.006.

81 Naomi S. Baron, *How We Read Now*, cit., ch. 6.

82 IEA, *PIRLS: Progress in International Reading Literacy Study*, cit.

83 OECD, *PISA 2015 Technical Report*, 2017.

84 Naomi S. Baron, *How We Read Now*, cit., ch. 6.

who took part in their studies – *can* produce some sound recommendations for everyone interested in growing in knowledge and awareness of reading and its processes.

Of some of these recommendations, I propose the following synthesis:

1. As clearly shown in Baron's work, the reading medium conundrum should not be considered a two-side-debate between paper and screen, but rather a polyphonic arena where multiple devices, materials, text genres, and reader types, needs, goals, and preferences interact and react to social, political, cultural, and economic factors that are in constant change and evolution. To navigate such a mutable sea of possibilities and support the training of 'multiliterate brains' – adopting and expanding Maryanne Wolf's 'biliterate brain' proposal[85] – in the contemporary and future readers, then, it is necessary to:
2. Stay on track and carefully analyse the latest results of the scientific research in the field. In particular, as we have presented above – but not limited to them – the many progresses in the neuroscience of reading and the studies of its embodied and sensorimotor properties. Far from giving straightforward and one-size-fits-all answers – as we have seen – research is nonetheless the – ideally – impartial and critical endeavour that allows to gain verifiable hints of knowledge about the many factors and processes underlying such a complex human ability as reading, as well as the multifaceted consequences of reading choices and practices. The results and interpretations produced by researchers can represent the solid – or as solid as the state of the research currently allows – basis that is so much-needed by readers, parents, educators, teachers, professors, policy-makers, and all those working in the vast world of publishing to make as informed and wise as possible decisions in their daily decisions about reading and the written culture. Moreover, the study of reading and its effects represents a precious common ground where humanities and sciences can converge and complement each other. Therefore,
3. Economic factors – albeit vital for both the producers of the written culture and its users – should not be the primary drivers of change, catching the wave of the latest technological innovation or consumer trend. While immediate returns and savings can appear more appealing and tangible compared to uncertain, debatable,

85 Maryanne Wolf, *Reader Come Home*, cit., p. 170.

> and seemingly subjective cognitive, affective, and social impacts, it should be kept in mind that a strong community of readers, capable of skilfully filtering, assessing, and learning from the abundance of written, audio, and video materials available nowadays would support a healthier society, where reading, in all its form, will be the core of community and individual cultural life. This, in turn, will not fail to produce medium and long-term benefits on all levels of society, economy included.

Finally, as Patricia Greenfield, Professor of Psychology at UCLA, pointed out:

> Every medium has its strengths and weaknesses; every medium develops some cognitive skills at the expense of others. [...] society needs reflection, analysis, critical thinking, mindfulness, and imagination more than ever. The developing human mind still needs a balanced media diet, one that is not only virtual, but also allows ample time for the reading and auditory media experiences that lead to these important qualities of mind[86].

If the progress in the research on reading has taught us something, we may conclude, it is that how, what, and why we read is a much wider story and with many more subplots than we had ever imagined. But also, maybe, much more far-reaching and fascinating.

86 Patricia M. Greenfield, *Mind and Media: The Effects of Television, Video Games, and Computers*, Cambridge (MA): Harvard University Press, 1984.