The Foreign Language Reading Brain: Connecting the Dots in the Age of Paper and Pixel

El cerebro que lee una lengua extranjera: haciendo conexiones en la edad del papel y el píxel

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Abstract

Since the early eighties, numerous experiments have been conducted in order to answer the following question: How does reading on paper differ from reading on screen? Our article presents a brief review of comparative studies in this field of research. We then look at reading models in L1 and L2 and posit that digitally displayed language actually provides a rich source of comprehensible input, and that foreign language readers can benefit from digital presentation of texts, in particular by way of eBook readers. We also highlight the inevitable and profound impact of Information and Communication Technologies (ICT) on the reading brain and, as digital literacy is fast becoming the norm in today's modern society, we draw attention to the pedagogical implication for foreign language teaching and learning.

Keywords: *Reading on paper versus reading on screen, reading models in L1 and L2, eBook readers, comprehensible input, ICT*

Resumen

Desde principios de los años ochenta, se han realizado numerosos experimentos para responder la siguiente pregunta: ¿cómo difiere la lectura en papel de la lectura en pantalla? Nuestro artículo presenta una breve revisión de estudios comparativos en este campo de investigación. Luego se analizan los modelos de lectura en L1 y L2, y se propone que el desplegar el lenguaje en la pantalla es una fuente rica de insumo de comprensión y que los lectores de lengua extranjera pueden beneficiarse de la presentación digital de los textos, especialmente a través de los libros electrónicos. También se destaca el impacto inevitable y profundo de las Tecnologías de Información y Comunicación (TIC) en el cerebro del

lector y, dado que la alfabetización digital está convirtiéndose cada vez en la norma de la sociedad moderna, se llama la atención a las implicaciones pedagógicas para la enseñanza y aprendizaje de lenguas extranjeras.

Palabras-clave: *Lectura en papel versus lectura en pantalla, modelos de lectura en L1 y L2, lectores de libros electrónicos, insumo de comprensión, TIC*

As information and communication technologies (ICT) gradually occupy many areas of our social, personal and professional lives, many researchers, neuroscientists, psychologists and educators, among others, are now questioning the nature of the impact these technological tools have on the human brain. Some researchers believe that when individuals are given a reading task on screen they fall behind when compared to subjects who perform the same task on paper. Other researchers also note that the use of computers may negatively impact the cognitive and physical aspects of the brain. In other studies, however, researchers debate the validity of these findings and report that reading on screen actually has many advantages.

The purpose of this paper is to find out if there are notable differences between reading on paper and reading on screen. First, we examine two succinct review articles that stand out in this field of research. Dillon's *Reading from paper versus screens: a critical review of the empirical literature* (1992) is a thorough review of the empirical literature between 1981 and 1992; *Computer – vs. paper-based tasks: Are they equivalent?* by Noyes and Garland (2008) covers a period from 1992 to 2006. These authors give us an overview of 40 studies and experiments undertaken between the years 1981 and 2006. Results as reported by these two researchers show that learners and participants in their majority demonstrated a preference for reading on paper. But before drawing a definite answer, we must approach these results with caution. As Dillon (1992) points out in his thorough study:

> One is struck in reviewing this literature by the rather limited and often distorted view of reading that ergonomists seem to have. Most seem to concern themselves with the control of so many variables that the resulting

> experimental task bears little resemblance to the activities most of us routinely perform as 'reading'. It is perhaps no coincidence that the major stumbling block of reader preference has been so poorly investigated beyond the quick rating of screens and test documents in post-experimental surveys (p. 1322).

Noyes and Garland (2008) arrive at the same conclusions:

> These early comparisons of computer- and paper-based tasks generally favoured paper for better performance according to the metrics of speed, accuracy and comprehension. However, inconsistencies in earlier findings could largely be attributed to variations in visual quality of the two presentations, in that like was rarely being compared with like (p. 1357).

We also looked at a series of articles published after 2006 to see if preference for reading on paper was still holding. As we review well known and established theories of the act of reading in first (L1) and second/foreign language (L2/FL), we also assess the applicability of these theories during the on-screen reading process. Our study looks at three domains of digital reading: the degree of comprehensible input, the teaching and learning of reading in foreign language acquisition, and the use of eBook readers in particular.

Learners today are fairly tech-savvy, and differences between reading on paper versus reading on screen are decreasing. As language teachers and pedagogues, we should not be primarily concerned if students take more time to complete tasks on screen; our main objective should focus on guiding our students to become better language learners regardless of the type of medium being used.

From the clay tablet to the digital tablet

Steve Jobs' DNA ancestry [1] takes us back 5,000 years in history. We are using this genetic term liberally of course, but we can surmise that the ingenious spark that gave us today's iPad was no more different than the Sumerian's creative mind that developed the first clay tablet to record business transactions. These first written records in the form of symbols, known as cuneiform, pressed on fresh clay would become modern tools of communication with the advantage of relieving individuals from the task of memorizing data. This was the beginning of reading and writing. Inevitably, new material discoveries and their applications would render these cumbersome clay tablets impractical. Thus, in the last 3,000 years, the medium changed: we moved to papyrus, then parchment and later to print paper. While these tools simplified social communication, they nonetheless imposed material and economical as well as cognitive constraints. Clay tablets offered a limited

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[1] Co-founder and chief executive officer of Apple Inc. from 2000 to 2011.

amount of data 'storage' and were weighty; although light, rolled papyrus was fragile; codex were time consuming and expensive to produce; paper books would have to wait until the 20th century to become affordable. Thus, for every new medium, the human brain had to adapt to different text presentations, orientations and densities.

With the advent of the LCD monitor, today's debate centered on reading is primarily preoccupied in demonstrating marked differences between reading on print and reading on screen and in showing the superiority of paper. Although we find this discussion very instructive, it should not deter educators of foreign languages to exploit the many pedagogical advantages that ICT provide. Whether reading on paper is superior or inferior to digital reading, we believe that no matter what differences are established, reading on screen will supplant reading on paper and the brain, thanks to its plasticity (Doidge, 2007; Li, Legault & Litcofsky, 2014), will again find ways to adapt to screen reading in the same manner that it had to adapt to reading on paper after the Gutenberg revolution.

Since ICT today dominate communication, the teaching of reading in foreign languages must also take its rightful place in the digital revolution. Indeed, reading literacy in a digital environment is an unavoidable required skill in today's world, as the authors of the 2009 PISA[2] Report justly point out. This document (OECD, 2010) now includes "a re-developed and expanded framework for reading literacy, which incorporates an innovative component on the capacity to read and understand electronic texts, thus reflecting the importance of information and computer technologies in modern societies" (p. 10).

Research findings: reading on paper versus reading on screen

In the last three decades, a number of experiments were conducted in order to understand the differences between reading on paper and reading on screen. Most studies were centered on the following tasks: proof-reading, comprehension, information retrieval, surveys, tests and exam questions, reasoning, personality assessments, interviews, essay composition among others. Comparative measurements were speed and accuracy. With regard to reading on screen many variables were also considered for assessment: screen design and size, colour background, margins and columns, typeface, line spacing, images and reading distance from the LCD monitor. Dillon (1992) and Noyes and Garland (2008) highlight those components that bear significance to our topic of study. They are as follows:

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[2] PISA is the acronym for 'Programme for International Student Assessment'. In 2000, the Organization for Economic Co-operation and Development or OECD began a worldwide study to assess 15-year old participants' academic performance on reading, mathematics and science. Literacy skills are assessed every three years and in a selected domain: thus, reading was assessed in 2000 and 2009 and will be measured again in 2018. When this study was launched, only 43 countries participated. In 2015, this number increased to 72. A panel of forty-one experts contributed to this 292-page study which was commissioned by the Secretary-General of the OECD.

On paper:

 a. proof-reading is 20-60% faster;
 b. comprehension tasks are performed much faster than on CRT, Microfiche and TV screen;
 c. better recall is noticeable;
 d. although there are no significant differences in multiple choice testing, electronic environment requires more attention;
 e. there are better scores on print in the Nelson-Denny Reading Test;
 f. problem solving is faster.

Reading on screen is better when:

 a. difficult questions are posed;
 b. information retrieval is being tested.

In their lengthy article, Macedo-Rouet, Ney, Charles and Lallich-Boidin (2009) also corroborate these two sets of results. The authors give a brief survey of 24 studies undertaken between 1997 and 2007 comparing Web versus paper-based learning. Of these studies, 22 were published after 2000. Macedo-Rouet *et al*. (2009) conclude that "most studies show mixed results, with both positive and negative aspects of each medium" (p. 376). Many of these experiments also attempt to find out if reading comprehension on paper is superior to reading on screen when speed and accuracy are key comparatives.

Indeed in many of these studies, results show that reading comprehension on paper is superior when factors such as speed and accuracy are assessed. But do these differences impact the way we teach and learn reading in a foreign language? Do these differences matter? It is worth noting in passing that reading on screen today is less of a daunting task than it was ten years ago. There are still ergonomic and graphic challenges that can have an impact on the students' performance, but most previous criticisms are no longer valid today. eBook readers are just an example: light is adjustable, pages can be flipped from right to left to right, two pages can be viewed on one screen, books are electronically adapted rather than digitized, and fonts can be made to look like those of print material. The tangibility of books and documents has now taken another dimension by way of interactive screens.

Beginning and skilled readers

For memory, let us summarize some basic notions of the reading process (Carrell, 1988; Cornaire, 1991). Contrary to speaking which is innate, reading is a learned skill for it takes years to master the techniques of decoding the graphic system. Reading is after all an intense physical activity that mobilizes several parts of our brain (Schiffmann, 2001). Thus, during a reading activity, we constantly exert pressure on our brain to decode signals that are placed before our eyes. Poor vision for example conveys the wrong signals to the human brain, which in turn produces a distorted physical or cognitive map (Hou, Rachid & Lee, 2017). We know very well that a child who has undetected poor vision will face intellectual and cognitive challenges. As our brain is progressively wired to the new

language system being learned, the act of reading involves "an array of mental or cognitive processes: attention, memory; and visual, auditory, and linguistic processes" (Wolf, 2007, p. 8). During our reading activity, we sense that our eyes extend widely onto the text in front of us, but this sensation of a panoramic view is just an impression. Actually, our eyes only cover eighty per cent of words of the passage being deciphered. And, depending on the language being examined, the eyes follow a movement from left to right – in the case of romance languages, marked by a series of saccades every 8-10 letters with a fixation of about 225-250 milliseconds (Beymer, Russell & Orton, 2008; Cornaire, 1991). The brain manages to cover seven/eight information units at a time that are temporarily kept within the realm of short term memory and later transferred to the long term memory. When it comes to reading comprehension, an expert reader would tend to use the lexical route – which is the representation of the visual word and its association with an image that is part of our lexical inventory. The beginning reader chooses the phonological route which becomes a deciphering exercise: the reader dissects the word into syllables that are translated into mental or vocalized sounds. In their seminal article, Coltheart, Rastle, Perry, Langdon and Ziegler (2001) suggest that readers automatically adopt a "dual route cascaded model" (p. 213), whereby the phonological and lexical routes are activated, and that they will choose the one that best helps them identify the word. Indeed, while this cascaded model is the norm espoused in our typical reading activities, the foreign language reader on the other hand would lean towards using the phonological route more heavily.

Reading models in L1 and L2

As was mentioned above, there are two ways of approaching the act of reading: lexical and phonological. The latter is used by beginning or inexperienced readers whose comprehension of the text is derived from a linear decoding of graphical signs - moving from letters to syllables, to the word, to the phrase, etc. This is a bottom-up approach as opposed to the top-down approach favored by experienced readers (Cornaire, 1991). Before even exploring the text, the skilled reader is first able to seize the text as a whole in order to quickly check any item that may hold useful clues – such as titles and subtitles, icons, pictures, layout presentation, structure, and then make inferences and elaborate hypotheses on the text's meaning. Is this process similar when we read a text in a foreign language? It is obvious that beginning and intermediate second/foreign language learners face several obstacles as a result of their weak or incomplete grammar mastery, their reduced lexical inventory and their L1 interference. These individuals tend to adopt a bottom-up approach, move their eyes slowly, have longer fixations and use frequent regressions.

The foreign language reading brain: reading on screen and pedagogical implications

Of the twenty articles published between 1981 and 1991 comparing paper versus computer (see Dillon's survey, 1992), fifteen studies looked into the speed factor in task completion. We noticed though in our reading of Noyes and Garland (2008) survey that this number dropped significantly in studies undertaken between 1994 and 2006. Only four

studies on speed were carried during that period, and seven articles examined participants' scores and the quality of their performance. Of these forty studies reviewed by Dillon (1992), Noyes and Garland (2008), one single article deals with a foreign language – a placement test for learning French (Weinberg, 2001). Although we recognize the importance of these forty studies, we find their conclusions limited due to the fact that screens can never faithfully replicate what is represented on paper. Therefore, further investigation is warranted, and as Kim and Kim (2013) rightly point out in their article, *Reading from an LCD monitor versus paper: Teenagers' reading performance* : "Determining whether computer presentation of text affects reading comprehension would be more difficult than the question of reading speed due to the difficulty of devising a suitable means of quantification" (p. 17).

There is abundant research literature detailing the many ICT applications and their practice in the foreign language classroom (Blake, 2016; Guan, 2014; Huang, 2014; Kessler, 2018; Levy, 2009; Park, Yang & Hsieh, 2014). The younger generations of language instructors who are now very familiar with the latest gadgets in technologies do not hesitate to put to test a variety of public and private programs and software. These instructors are already remodeling the 'pedagogical triangle' (Legendre, 1988) where the relationships between teacher, learner and knowledge or object of teaching are being reassessed and, thanks to their acquired technological know-how, tech-savvy students seem to embrace this new learning configuration where they are empowered to become autonomous learners (Shang and Chen, 2018). However, unless this pedagogical triangle is well thought out, instructors run the risk of demotivating their students (Elkabas & Wooldridge, 2011). Reading activities feature prominently in the foreign language curriculum because they provide an important source of comprehensible input to students, and as a result, this helps them build up their lexical inventory (Krashen, 2004). But, with regard to the use of computers for reading instruction, Krashen (2008) cautions against most program applications. For this author, these applications are based on the traditional 'Skill-Building Hypothesis' which implies "that we develop competence in language and literacy by first 'learning about' language, that is, consciously learning the rules, and by deliberately studying vocabulary" (Krashen, 2008, p. 178). In opposition to this traditional principle, Krashen (2008) rightly defends his 'Reading Hypothesis' which is "the claim that reading is the source of much our vocabulary and spelling competence, our ability to handle complex grammatical structures, and to write with acceptable writing style" (p. 180).

For Krashen then, the best way to use the Internet as a source of reading may be

> 'free voluntary surfing', or FVS. In FVS, as in free voluntary reading, students read what they want to read (within reason), with no accountability, no follow-up exercises, no assigned topics, and no vocabulary list that they must try to remember. (Krashen, 2008, p. 184)

However, we must keep in mind that even 'free voluntary surfing' could present many

technological and pedagogical challenges. This concept is certainly attractive, but one should first of all insure that learner-surfers possess the right navigating reading strategies. Indeed, whether they are reading online or attending to on-screen guided reading tasks, learners should be taught pertinent reading strategies. Park, Yang and Hsieh (2014) draw a helpful reading guideline for good reading practices. According to these researchers, good readers call upon their prior knowledge of the topic, of Internet services and their affordances, of informational web structures, of printed text structures, and of computer skills.

Student assessment

Of particular concern is the administering of reading comprehension tests on screen. Since these represent a standard mode of assessment in the foreign language classroom, our general tendency would be to replicate on screen the layout model used for paper. We type a text borrowed from an authentic document, or we photocopy a newspaper article, a passage from a novel or a non-fiction book; then we transfer it as a document to screen or we scan it as a PDF. A series of questions - multiple choice items or open ended questions- normally follow the text presented. In a recent study (Mangen, Walgermo & Brønnick, 2013), 72 tenth graders in Norway were divided in two groups. One group read a text on screen in a PDF format; the other group read the same text in print in an identical PDF layout. Participants from both groups answered questions on screen; those who read the PDF text in print received higher scores in reading comprehension. Although they have no definite answer, the authors of this study suggest that participants in the screen test may have been hindered by constant navigation and scrolling (going from the PDF document window, to the questions window) while participants in the print condition were able to experience a complete spatial effect of the paper and more fully comprehend the text in its entirety. This experiment may therefore signal that poor performance of students in the screen condition is not necessarily the consequence of inferior reading skills but rather the less intuitive aspects of handling technology that become a contributing factor in poor reading comprehension. Two important lessons can be learned from Mangen, Walgermo and Brønnnick's (2013) experiment when one administers reading comprehension tests in a foreign language: 1. Scrolling has a negative impact; 2. Reading text and questions must be contained in one single window in order to avoid the negative impact of on-screen navigation.

The solicited brain

Students read a lot; while perhaps not reading what we would like them to read – Dostoyevsky, Dante, Cervantes, and Hugo or other classics – they are reading constantly (searching on Google, Wikipedia and social media), text messaging, reading blogs and digests of current events. They know what they are seeking, they are curious, and they have their personal reading strategies. But reading on screen in a foreign language is as complex as reading on screen in L1.

In these modern times, as technology opens boundless opportunities, humans must confront new challenges every day. Levitin (2014) in *The Organized Mind* reminds us that our brain is constantly bombarded with information (radio, street noise, music, phone rings, emails, movements in the street, infographics, etc.) and that we attend to those that need our immediate attention. However, when we are expected to process them all instantly, the brain is overworked. Levitin (2014) calls this situation a "cognitive overload" (p. 7).

> Our brains do have the ability to process the information we take in, but at a cost: We can have trouble separating the trivial from the important, and all this information processing makes us tired. Neurons are living cells with a metabolism; they need oxygen and glucose to survive and when they have been working hard, we experience fatigue (Levitin, 2014, p. 6).

For language learners, cyberspace which is a "non-linear online reading environment" (Park, Yang & Hsie, 2014, p. 161) can turn into the longest of journeys. Attention-seeking stimuli and distractors such as pop-up windows, flashing signals for cookies, multiple headlines, cues for inter- and extra-navigation, commercial enticements, are all competing in such a way that the brain's "attentional filter" is unsettled (Levitin, 2014, p. 7). Faced with this plethora of distractors, the brain is at a crossroads. To borrow Levitin's analogy: "The decision-making network in our brain doesn't prioritize" (Levitin, 2014, p. 6). This additional challenge presents a new source of stress to the foreign language reading brain.

Language instructors are eager to use the web because it is a valuable source of authentic documents and useful reading materials, but when assigning task-based projects with this medium, they must be aware of the many challenges their language students face. Paradoxically, the web is the tool that can best build up students' comprehensible input and bring together a community of highly interested and motivated learners. Content-based instruction and activities such as task-based projects are also extremely constructive (Ellis, 2003; Long, 2015; Thomas & Reinders, 2010).

As noted in many research studies, when students read on screen, they fail to match the performance of their peers who read on paper because they practice skimming and scanning techniques. But, rather than seeing these two techniques as a handicap for teaching and learning foreign languages, we believe these techniques can act as a counterpoint to the cognitive overload. In actuality, students should be taught how to quickly examine the general content of an article or to locate needed information to swiftly accomplish their tasks. Indeed, the profile of the good language reader is an individual who perfects the techniques of skimming and scanning, is able to identify the type of text (narrative, descriptive, directive, expository, or argumentative) and its structure, and uses cues such as graphics, pictures, titles, and subtitles to make inferences before even engaging in the act of reading. When confronted with a crowded web page, students should be taught how to practice a top-down approach and make inferences right from the start.

eBook readers as a useful pedagogical tool

Many studies undertaken since the 1980s comparing reading on screen and reading on paper demonstrate that individuals who read on screen received lower test scores. eBook readers for example were used as one medium for comparison (Connell, Bayliss, & Farmer, 2012; Coyle, 2008; Jeong, 2010; Margolin, Driscoll, Michael, Toland, & Kegler, 2013; Pinto, Pouliot, & Corton-Garcia, 2014; Staiger, 2012; Wright, Fugett & Caputa, 2013). At present, we would like to revisit some particular features of this reading tool which, it seems, have had a negative impact on participants' interest and performance (Chou, 2016; Clark, Goodwin, Samuelson, & Coker, 2008; Connell, Bayliss, & Farmer, 2012; Torres, Johnson, & Imhondy, 2014). For example, backlight and font type and size were found to be tiring for the eyes and affect the quality of reading performance and comprehension. Regardless of their length, texts were presented in one single page and one had to scroll down to study, read or view the document. It was also difficult to locate the place where one had stopped reading. Understandably these characteristics can become a hindrance to sustained or deep reading, but technology evolves at a rapid pace, and today newer features in eBook readers are a welcome sign to general readers and to foreign language learners in particular (Qian, 2011). Most commercial eBook readers offer multiple options that transform the reading activity as close as possible to the one we engage in when reading on paper: use of E Ink, easily-affixed bookmarks to return to a page after a pause; print and type setting as varied as those found in paper books (Zeng, Bai, Xu, & He, 2016), page-flipping and adjustable background contrast. These eBook readers have other features that paper books could never match and that are pedagogically useful to the L2/FL learner: looked-up words inventory, integrated dictionary and other language tools, intra-text navigation, easy access to in-line footnotes, and virtual stickie margin notes. These options and other audio functions offer multiple pedagogical possibilities in the classroom and bring much support to language learners whose tendency is to become autonomous in their adopted digital habitat. As ICT become prevalent in our society, we just cannot ignore the impact digital texts may have on our teaching and learning foreign languages (Chou, 2016). Consequently, accepted theories on reading, top-down and bottom-up, Gestalt and schemata (Ajideh, 2006; Carrell, & Eisterhold, 1983; Goodman, 1988; Shuying, 2013) will inevitably have to be revised in light of technological developments when we take into consideration other modes of text presentation such as graphics, signs, images and integrated auditory clips. Therefore, to know how to read in this modern age implies being able to move from the state of being literate to that of being transliterate. As Thomas, *et al.* (2007) propose: "Transliteracy is the ability to read, write and interact across a range of platforms, tools and media from signing and orality through handwriting, print, TV, radio and film, to digital social networks" (n. p.).

Conclusion

As reported by Dillon (1992), Noyes and Garland (2008), and Macedo-Rouet, *et al.* (2009), the majority of experimental testing shows that reading on screen is slower than

reading on paper. But as Noyes and Garland (2008) justly point out in their thorough investigation, researchers' findings are inconclusive due to the fact that it is very hard to establish balanced comparative indicators "since two different presentation and response modes are being used" (p. 1371). Moreover, we believe that because most of these tests were administered to individuals who are not truly 'digital natives', it would be hasty to draw definite conclusions with regard to on screen reading performance. Above all, individual digital skills and literacy are important factors as Sun, Shieh and Huang (2013) remind us: "Reading from computer screens requires a certain degree of individual technical skill. However, most researchers did not objectively take the variable into account when conducting an experiment regarding the comparison between print and screen reading." (p. 90) Only in the next decade, thanks to international investigations that are being carried out by the OECD (2010), will we be able to see a larger and much clearer picture of students' reading literacy and to measure their digital navigation skills.

Interestingly though, a number of researchers offer a different picture of technology-assisted foreign language learning. Their articles do not focus on speed and time factors but rather on the quality of the participants' performance in FL. Good results, we read, are best obtained when students are taught a strategies-based reading approach (Huang, 2014), when they are trained for online self-learning (Shang & Chen, 2018), and when they activate their prior knowledge during their reading (Park, Yang, & Hsieh, 2014). Thanks to their integrated resources and mobility, eBook readers were seen favorably by the majority of students (Chou, 2016; Clark, Goodwin, Samuelson & Coker, 2008).

Will the next generation of learners more easily navigate the meanders of cyberspace? Will their brains be wired differently? To these questions our answer is in the affirmative. Humans, as we all know, are not pre-programmed to read, but our brain has the admirable plasticity that allows us to adapt to new forms of communication and "the ability to learn to connect and integrate at rapid-fire speeds what it sees and what it hears to what it knows" (Wolf, 2007, p. 8). Thus, when it is highly stimulated through various sensory interactions, the adult brain is constantly reorganizing and reconstructing itself (Schiffmann, 2001). According to Schiffmann (2001), if the conditions are met, the brain has the potential to create an infinite number of neuronal connections with the benefit of maintaining and strengthening cerebral functions. For this reason ICT, with their boundless amount of visual and cognitive distractors, may actually increase the quality of the brain's activity. Nevertheless, reading on screen may have undesirable effects: 1. Physical – frequent users are now showing signs of asthenopia and computer vision syndrome (Rosenfeld, 2011); 2. Cognitive – reading and multitasking do not make a perfect combination because they confuse our attentional system (Ackerman & Goldsmith, 2011; Levitin, 2014; Mangen, Walgermo and Brønnick, 2013; Subrahmanyam et al., 2013). Referring to his "attentional switching" principle, Levitin (2014) remarks: "Multitasking is the enemy of a focused attentional system" (p. 16). Indeed, cyberspace distractors could have a negative impact on foreign language learners at the beginning level, but instructors can promote the use of eBook readers in order to partially alleviate this problem.

Computers, tablets, eBook readers and other devices such as smartphones are part of our daily digital landscape, and we are often told that students prefer these modern tools of communication. As technology evolves, foreign language instructors will have to adapt to their students' reading habits and understand the pedagogical implication of digital reading. But even if today's reading on screen presents a number of challenges, surely the human brain will find ways to develop new neuronal pathways for reading in order to circumvent those obstacles. In his book *The Organized Mind*, Levitin (2014, p. 15) lists a series of famous authors who complained about the disruption caused by the incursion of writing or who found the large and public dissemination of books threatening; Plato, Seneca the Younger, Erasmus, Leibnitz, Descartes are just a few. Levitin (2014) continues with these ironic remarks:

> Intellectuals warned that people would stop talking to each other, burying themselves in books, polluting their minds with useless, fatuous ideas. And as we well know, these warnings were raised again in our lifetime, first with the invention of television, then with computers, iPods, iPads, e-mail, Twitter, and Facebook. Each was decried as an addiction, an unnecessary distraction, a sign of weak character, feeding an inability to engage with real people and real-time exchange of ideas (Levitin, 2014, p.15).

"An addiction" perhaps, but we must accept the fact that communication and human interaction have never been as widespread as today.

We recognize that those individuals positioned between pre- and post-ICT (MTV Generation – X and Echo Boom Generation – Y) face certain obstacles when they read texts online, but there is no doubt that today's 'screenagers' or millennials (iGeneration) will be lodged in their natural digital habitat and will have already developed new reading brain circuits well before 2030. As technology moves forward, so will follow the foreign language reading brain.

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