

Neuroscience and psychological studies sustain the cognitive benefits of print reading

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Abstract On behalf of the Journal of Cell Communication and Signaling Editorial board it is my great pleasure to present through this message of peace and love our warmest wishes of health, happiness and professional success. We sincerely hope that 2017 will be a peaceful year worldwide and that solutions will be brought to resolve the great tensions that crystalized last year into terrible acts of violence which reflected the inability of the political powers to bring satisfactory solutions to human despair and fear. The year 2017 will be the time for celebration of the 10th JCCS anniversary and 9th International Workshop on the CCN family of Genes. Both events should allow us to meet in a productive interactive way. I have had the opportunity to express several times in these columns my deep belief in the power of communication at all levels of human biological and social interactions. Indeed, « Communication is the key » at large.

Keywords Learning · Communication · Behavior · Print publishing · Printreading · Electronic reading · Neuroscience · Psychology · Cognitive benefits · CCN proteins · Extracellular microenvironment · Cellular signaling · Cell behavior · International CCN society · International workshop on the CCN family of genes

Perbal B. Communication is the key. (2003) Cell Commun Signal. Oct 27;1(1):3.; Perbal B. Communication is the key. : Part 2 : Direct to consumer genetics in our future daily life ? (2014) J Cell Commun Signal. Dec;8(4):275–87; Perbal B, Perbal A (2015) Liberté, liberté chérie. J Cell Commun Signal. Mar;9(1):1–4

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JCCS: ten years of constant quest for quality

As I have discussed in a previous editorial,¹ the Journal of Cell Communication is the outcome of a dedication, shared by a group of colleagues who constituted the first JCCS editorial board, to offer members of our scientific community a platform that would permit publishing and critical reviewing of progress made in the understanding of intercellular communication mechanisms, that involved both the internal cellular circuitry responsible for sending the ultimate information to the « command center », and the much less understood array of signaling « actors » and means in charge of cell cross-talk within and outside organized tissues.

Born in 2003, our first « Cell Communication and Signaling » journal, one of the first « open access » among the burgeoning number of scientific on line journals, became the Journal of Cell Communication and Signaling » with Springer in 2007.

Ten years of hard work shared with dedicated editors who helped the Journal survive stormy times of scientific publishing that resulted both in the disappearance of old publications and birth of hundreds of electronic journals among which too many, unfortunately, provide a questionable scientific content.

At JCCS, we have fought against external commercial pressures to ensure, with the internal support from Springer, that our journal publish only peer-reviewed articles that bring solid and reliable scientific data on which others can build up experimental models and participate to both knowledge progress and improvement of life quality, two strong drivers to our entire team.

¹ Perbal B (2015) What kind of a life for a scientific journal? J Cell Commun Signal. Sep.;9(3):201–6

Because of our interests in a family of signaling proteins which turned out to be critical players in many aspects of cell communication, both in normal and pathological conditions,² JCCS served as the official journal of the International CCN Society and a medium of choice to support publications in the CCN-related fields.

Evidence that has accumulated over the past decade has put CCN proteins at the center of a whole array of essential regulatory signaling mechanisms and cellular growth control.

JCCS: a focus on extracellular environment and cell behavior

By focusing on the action of extracellular factors in the cellular microenvironments that govern the fate of cells in normal and pathological conditions, JCCS had covered, from its very early days, a unique niche before it became a « fashionable » topic.

The translation angle that we aimed for, in addition to more conventional cellular biology approaches, contributed to give JCCS its worldwide recognition in various fields that include, among others, cardiovascular homeostasis, nervous system development and cognitive processes, bone and cartilage development, skin regeneration and differentiation, matrix biology, IGF signaling, and basic signal transduction processes.

In 2016, the number of manuscripts downloaded from the JCCS website nearly doubled that in 2015.

Let me take this opportunity to sincerely thank, once more the JCCS section editors (D. Brigstock, S. Kubota, A. Leask, H. Yeger) and managing Editor (A. Leask) for their tremendous support in developing our journal, A. Perbal for her sustained advertising mailings and all the members of the JCCS editorial board whose widely recognized expertise has been pivotal to widen the topics of our journal and open our pages to potential authors from other fields.

This significant increase in download numbers, which results from the strong dedication of the whole crew and increasing quality of the manuscripts submitted, strongly reinforces our incentive. About 20% of the submissions did not make it to publication. Some of them were just out of the scope of JCCS.

The earning of a 3.123 Impact Factor from Reuters Thomson, which is considered by most administrative agencies as a standard tool of scientific quality, and the unique position of JCCS in the world of intercellular signaling journals have helped JCCS to pursue its objectives to reach the highest standards in scientific publication.

We would like to invite all our readers to take advantage of the increasing scientific recognition and publishing expertise

of JCCS, and the worldwide distribution of Springer publications, to help us in our endeavor.

From very early days, and this was one of the reasons we discontinued publishing CCS at BMC, we wanted the Journal of Cell Communication and Signaling to offer a printed version in addition to online access. Recent published data and a poll that we have run amongst our board members confirmed the need to maintain printed publications as many researchers still like to have at hand a printed version. Why is it so?

Print reading appears to better impact comprehension, learning and communication

A few years ago, many analysts and publishers were ready to consider that paper printing was to vanish, not only because of the production cost of journals or books that end up to have a short shelf life, but also because the blossoming of new internet technologies applied to printing and distribution of electronic books and journals (e-publishing) would permit rapid worldwide transmission of information and culture, thereby serving « an important need in disseminating scientific and scholarly information » and adding « another dimension to the various ways that we as a society share knowledge » (Ulaby 2006).

A decade later, it seems that things did not move exactly this way.

Some publishers once tempted to stop the production of printed issues, realized that there is still a need for this kind of support and several online journals also came to include printed issues.

In her paper entitled « there's something about paper »,³ Froma Harrop questions herself about the fact that « the tech website C|NET has started publishing an old fashioned magazine- you know, on paper, like Time and Life » while the digital technology was « supposed to do away with paper » C|NET also carries printed adds for a few big companies. The parent company CBS⁴ explains that it is « another way to get at C|NET's wares ».

Several cognitive studies have indicated that reading printed journals and books offer significant advantages over digital.

In order to evaluate the extent of reading modality on comprehension a group of 72 tenth graders were asked to read two texts, either in print or as a pdf on a computer screen.

The multiple regression analysis that was performed indicated that « students who read texts in print scored

² Perbal B. CCN proteins: A centralized communication network. (2013) J Cell Commun Signal. Aug;7(3):169–77;

³ F. Harrop (2014) There's something about paper. <https://www.creators.com/read/froma-harrop/11/14/theres-something-about-paper>

⁴ Columbia Broadcasting System <http://www.cbs.com/>

significantly better on the reading comprehension test than students who read the texts digitally » (Mangen et al., 2013).

In another study, Santana et al. after presenting an extensive literature review of the field, provided data which established that print readers recall more than do online readers (Santana et al. 2013).

Readers interested in this topic should consult the discussion by Larry Ferlazzo⁵ from which it stems that i) within a limited period of time, reading on paper appears to be more efficient, with less fatigue. This is a consistent finding. As a result, students end up reading more quickly the paper version (Ackerman & Lauterman, 2012, Daniel and Woody 2013, Chen et al. 2014) ; ii) non linear reading is insufficient for deep reading comprehension, while it is fine for pleasure or for finding key words iii) « It is critical that students' brains engage regularly in linear reading, because this type of reading leads to the ability to understand complex sentences, identify hidden meanings, interpret difficult syntax, develop a deep understanding of the story or content, and engage in sustained attention ».

Consulting tables of content and selecting articles of interest through an electronic subscription offers an obvious interest. However, the cognitive impact is quite different from that created through reading a printed text that appears as a whole, embodied in the structure of an issue that can be manipulated, marked and exposed to others in very easy ways. Scrolling through digital text impairs the comprehension process (Connell et al. 2012).

The role of spatial information, « kaleidoscopic in nature », ⁶ has also been highlighted in several studies.

In a study run over two years during which she collected data from 429 university students originating from the USA, Japan, Germany, Slovenia and India, N. Baron⁷ gathered that print gave the students a sense of where they were in the book – they could “see” and “feel” where they were in the text. Print was judged to be easier on the eyes and less likely to encourage multitasking that is a distracting temptation resulting from the numerous hyperlinks present in a digital text. The nonlinearity of digital media as well as the ease with which its readers can move quickly and repeatedly among several electronic elements leads to a reading experience characterized by “online multitasking and lack of cognitive

focus”⁸ « When asked on which medium they felt they concentrated best, 92% replied “print.” For long academic readings, 86% favored print. Participants also reported being more likely to reread academic materials if they were in print ».⁹

Three levels of spatial connection and interaction with what the reader reads need to be considered.¹⁰ They involve Haptics, Flipping and scanning, Navigation and Topography.

Haptics is a non verbal mode of communication which is based on touching. Printed books and article fulfill the need for touching, turning the pages, perception of the letters as physical objects. Mental maps are created upon reading printed text. Everyone has experienced the memory of that particular topic, line or subject, at the top or at the center left of a particular page, and this other one at the second page of the first chapter...

« Paper is an information carrier par excellence and possesses an intimacy of interaction that can never be obtained in a medium that by definition imposes a microchip interface between the reader and the text” (A. Dillon, 1992).

E. print readers lack that « physical intimacy with paper », ¹¹ they do not get a sense of the whole text that they read and they miss the « flipping and scanning » which is considered as a key behavior associated with printed documents¹² , as it refers to the topography of the text, a sense which is lacking in digital reading.

The processing of information that occurs upon print and electronic reading is known to be different. Considering that « navigational differences may subtly inhibit reading comprehension » F. Jabr (2013) in his thoughtful analysis of recent research in the fields dealing with the psychology of reading and neuroscience, concluded that « compared with paper, screens may also drain more of our mental resources while we are reading and make it a little harder to remember what we read when we are done”.

Two recent neuroscience studies were conducted by the US Post Office in collaboration with Temple University,¹³ and by the Canadian Post who partnered with the leading neuromarketing research strategy firm True Impact Marketing¹⁴ in order to analyze the behavior of customers responses to electronic and print advertizing of their services.

⁹ Ibid note 8

¹⁰ A Cognitive Analysis: The Advantages of Print over Digital Media (2014) July 9 <http://www.mamumediallc.com/blog/2014/7/9/a-cognitive-analysis-the-advantages-of-print-over-digital-me.html>

¹¹ Ibid note 10

¹² Liu, Z. (2008) “Reading Behavior in the Digital Environment.” In Paper to Digital: Documents in the Information Age, by Ziming Liu. Westport, CT: Libraries Unlimited.

¹³ RARC Report Report Number RARC-WP-15-012 Enhancing the Value of Mail: The Human Response (2015) 15 june. <https://www.uspsio.gov/sites/default/files/document-library-files/2015/rarc-wp-15-012.pdf>

¹⁴ A BIAS FOR ACTION The neuroscience behind the response-driving power of direct mail. (2015) July 31 https://www.canadapost.ca/assets/pdf/blogs/CPC_Neuroscience_EN_150717.pdf

⁵ L. Ferlazzo 28 May 2016 Response : Reading digitally vs. Reading Paper. Education week Teacher. An interview featuring responses from Willingham Professor Daniel of Psychology at the University of Virginia, Kristin Ziemke, Lester Laminack, Professor Emeritus, Western Carolina University and Kimberly Carraway, EdM, a learning specialist and educational consultant http://blogs.edweek.org/teachers/classroom_qa_with_larry_ferlazzo/2016/05/response_reading_digitally_vs_reading_paper.html?cmp=SOC-SHR-FB

⁶ Kristin Ziemke ibid. note 6

⁷ N. Baron (2016) Why Digital Reading Is No Substitute for Print <https://newrepublic.com/article/135326/digital-reading-no-substitute-print>

⁸ B. W. Cull, (2011) “Reading Revolutions: Online Digital Text and Implications for Reading in Academe.” First Monday (16: 6), <http://firstmonday.org/ojs/index.php/fm/article/view/3340>



Fig. 1 A message of peace and love for 2017

Research techniques employed by the Canadian teams involved Electroencephalography (EEG) and eye tracking to follow subject's attention. Participants were surveyed before and after the tests took place and were also subjected to memory tests.

The results of the tests indicated that direct mail proved the most effective media for advertizing as compared to digital (email and display). The conclusion drawn suggested that physical media are better suited to close marketing-sales loop or the gap between interaction and action.

The tests performed by the US groups were based on eye tracking, biometrics, traditional behavior analysis, and functional Magnetic Resonance Imaging (fMRI) that measures brain activity changes associated with blood flow.

The results of the study indicated that even though they appeared to process digital adds more rapidly, the subjects spent more time with the physical adds that triggered stronger emotional responses and memorisation.

« Physical ads, though slower to get one's attention at first exposure, leave a longer lasting impact for easy recall when making a purchase decision ».

More importantly for the marketers running advertizing, the physical adds triggered activity in the ventral striatum area of the brain which « is responsible for value and desirability for featured products ».

These two sets of results argue for a stronger impact of printed over digital information. However, as stated by R. Dooley,¹⁵ « Even where print remains an important medium, of course, an exceptionally good digital experience is necessary both to complete print-driven sales and originate sales independently ».

This conclusion also stands for human activities based on productive communication that include an efficient, rapid ex-

change of information, which can be processed in the most profitable way by our cognitive senses in order to provide means of knowledge progress and fruitful use of previous experiences.

« It remains to be seen whether or not the very different process of reading on screen and online will lead to students who are, as Maryanne Wolf¹⁶ has predicted, atrophied readers of print ... Therefore we may need to remind ourselves of the importance of teaching transferable critical reading skills, and the value of motivating our students to remain lifelong learners who practice the skill of in-depth reading throughout their lives, no matter where our information technologies may take them in the future ».¹⁷

This is the line of conduct that we, at JCCS, will follow to ensure that our readers get the best quality science and experience.

Again, Happy New Year to all (Fig. 1).

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¹⁵ R. Dooley Print vs. Digital: Another Emotional Win for Paper (2015) July 8 <http://www.neurosciencemarketing.com/blog/articles/print-vs-digital.htm>

¹⁶ Maryanne Wolf, 2009. Personal interview with Barry Cull, at Cambridge, Mass. (21 November). Cited by B. W. Cull (2011), refer to note 8

¹⁷ *Ibid* note 16