

IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGIES ON HUMAN COGNITIVE PROCESSES. IMPLICATIONS FOR HUMAN NATURE

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ABSTRACT: Information and Communication Technologies (ICTs) have dramatically changed the way we access knowledge and process data, how we learn and work and the way we relate to other human beings. Given that their mainstream incorporation to daily life is relatively recent their consequences on our psychology and behaviour are only beginning to be explored. The growing interest in this topic manifests itself in a myriad research works that study the associated phenomena from different angles. However, a unified perspective is still missing. This paper attempts to fill that gap by providing a summarized view of the consequences that the use of ICTs is having on our intellectual abilities and the way we view ourselves as human beings.

KEY WORDS: information and communication technologies, learning, memory, attention, multitasking.

El impacto de las Tecnologías de la Comunicación y la Información en los procesos cognitivos humanos. Implicaciones para la naturaleza humana

RESUMEN: Las Tecnologías de la Comunicación y la Información (TCIs) han cambiado drásticamente la manera en la que accedemos al conocimiento y procesamos datos, cómo aprendemos y trabajamos y nuestra manera de relacionarnos con otros seres humanos. El interés creciente que despiertan las consecuencias del uso de las TCIs se ha manifestado en múltiples estudios aislados que analizan estos fenómenos desde puntos de vista diferentes. Este artículo tiene como objetivo proporcionar una perspectiva unificadora de estos trabajos, reflexionando sobre las consecuencias que el uso de las TCI está teniendo en nuestras habilidades intelectuales y en cómo nos percibimos a nosotros mismos como seres humanos.

PALABRAS CLAVE: tecnologías de la comunicación y la información, aprendizaje, memoria, atención, multitasking.

1. INTRODUCTION

Traditional epistemological models classify knowledge in separate disciplines with different objects of study and specific techniques. Some of these classifications even assign hierarchical levels to each branch of knowledge, with Comte's Theory of Science providing one of the most well recognized frameworks (Comte, 1868). For Comte, all known disciplines could be arranged into a continuous from mathematics to astronomy, physics, chemistry, biology and, lastly, sociology. The order in which Comte ordered the sciences reflected increasing complexity and generality of the subject, which contrasted with a decreasing complexity of the instruments applied by each discipline.

As will be further detailed in this article, recent studies seem to show that technology is affecting the structure of our thinking processes. Very importantly, digital storage and easy information access —notably, on the Internet— means that the need to commit data to memory in daily life is not as usual as it once was. Telephone numbers, historical

facts, all sorts of general and personal information are readily available for anyone independently of their retentive abilities. Similarly, calculators and software tools such as spreadsheets have greatly reduced the need to perform arithmetic operations. ICTs are taking over these and other tasks, progressively decreasing their prevalence in the routine activities of the general population. A lack of practice can typically imply the degeneration of the capability itself. Whether or not this is the case has been the object of several studies which will be reviewed in this article.

ICTs have also modified the structure of the workday for a vast majority of the population. Office jobs are predominantly based on the use of computer tools, and electronic communications are essential. These professional communications, as well as the personal ones, create an interplay of constant interruptions that adds up to the multitasking load of a fast-paced environment. These changes certainly have an impact on productivity, which some research works have tried to objectively assess.

In addition, the availability of ready-made solutions for common problems has resulted on a decreased need for building solutions both at the workplace and at home. Computer code recipes, laundry tricks and step-by-step guides for almost everything can be found online. Has a «just google it» generation been born?

Finally, the fact that technology is taking over some of the activities that were once considered exclusively human casts doubts on precisely how the *humanity* of an activity should be defined.

This paper reviews these questions, providing with a general background on the most important studies that researched them, as well as paving the way for the reflection that seems so necessary at this time. The article is organized as follows. First, section I examines the impact that ICTs have had on our memory. Then, section II surveys the assessed consequences of ICTs on attention. Finally, section III presents a general perspective on the consequences of the previous points on independent thought and on the understanding of what is exclusively human.

2. EXTERNAL VS. PERSONAL MEMORY

Memories fade and retention is limited, but writing meant that the boundaries of personal retentiveness could be overcome and, moreover, information could be shared within a community. In addition, the possibility of keeping written records greatly reduced the need to memorize data. The lack of necessity and the consequent loss of practice have caused concerns that the ability to remember itself would be compromised since as early as Plato:

«If men learn this, it will implant forgetfulness in their souls; they will cease to exercise memory because they rely on that which is written, calling things to remembrance no longer from within themselves, but by means of external marks. What you have discovered is a recipe not for memory, but for reminder. And it is no true wisdom that you offer your disciples, but only its semblance, for by telling them of many things without teaching them you will make them seem to know much, while for the most part they know nothing, and as men filled, not with wisdom, but with the conceit of wisdom, they will be a burden to their fellows.»¹

¹ Plato, «Phaedrus», Penguin Classics, 2005 edition.

ICTs have made it easier to store and access all kinds of information, dramatically increasing our external memory, so that this effect has been exacerbated. The main question is whether the ability to recall information actually deteriorates with the lack of practice, and what consequences that loss would have. Although memory studies have traditionally focused on memory-related conditions related to injury, disease or age², recent studies have also focused on examining the relationship between recalling capability and exercise, with most works confirming that the lack of practice results in a deterioration of the memory ability itself³. Some authors have made a distinction between personal memory and external memory, with personal memory being divided into natural memory—with which the individual is born—and artificial memory, which can be developed by learning⁴. Artificial memory then turns out to be a greatly important part of individual memory, and results greatly compromised as a result of any lifestyle changes that reduce the need for memorizing itself. In particular, Sparrow⁵ has shown that when subjects expect to have future access to information, they have substantially lower rates of recall for the information itself and remember instead where to look for it. Our minds are built to minimize effort, and therefore ICTs minimize reduce the effort put into developing artificial memory.

Furthermore, there is some evidence that indicates that there has already been some deterioration in memory skills for the past couple of generations, with, for instance, our grandparents being able to recall their trips far better without relying on the visual clues provided by photographs. Some authors define a relationship between the changes in pedagogical methods over the past decades, which de-emphasized learning by memorization and have resulted in a decline in recall abilities⁶. There are already some voices calling for reintroducing elements such as poetry memorization into education, which has been shown to enhance text comprehension⁷.

ICTs are increasingly present in our daily lives, where they keep eliminating the need for memorizing data. In particular, mobile devices store our contacts, agendas and routes. Several publications have warned about the pernicious effect they are already having on our memories⁸. We can only imagine the impact that they will have in future generations but it seems that, for sure, the humanity of the future will struggle more than we do—and certainly more than our grandparents did—to recall information.

The consequences of this memory loss have been widely debated. On the one hand, memory and learning have a deep connection, and it was for a reason that «*Mnemosine, the goddess of memory, was also the goddess of wisdom and the mother of the muses*»⁹.

² ROGERS and FIRSK (2006): «Cognitive support for elders through technology», *Generations*, 30(2), pp. 38-43; SAMUEL (1999): *Memory. How we use it, lose it and can improve it*. New York: New York University Press.

³ PARKER (2009): «A Different Kind of Memory: Examining the Effect of Technology through the Ages», *DJIM* 4.

⁴ YATES (1966): *The art of memory*. Roulledge and Kegan Paul editions.

⁵ SPARROW *et al* (2011): «Google effects on Memory: Cognitive Consequences of Having Information at Our Fingertips», *Sciencexpress*.

⁶ PARKER (2009): o. c.; WEISS (2000): «Memory and Learning», *Training and Development*, 54 (10), pp. 46-50.

⁷ MUSKE-DUKES (2002): «A lost eloquence», *New York Times*, Dec 29.

⁸ BRISCOE (2000): «When computers chip away at our memories», *UNESCO Courier*, 53(12), pp. 44-45.; CARR (2008): «Is google making us stupid?», *The Atlantic*, July/August; JOHNSON-LAIRD (1988): *The computer and the mind: an introduction to cognitive science*. Cambridge University Press; WALSH (2008): «Who needs a good memory when there is google?» *The Christian Science Monitor*, 9.

⁹ RADSTONE (2000): *Working with memory. An introduction*. Memory and Methodology, Berg.

On the other, there have been claims that the use of aids to memory frees energy and capacities to be used in other more interesting activities¹⁰. However, research indicates that this is actually not the case. First, it seems that the human brain's memory capacity is so high with respect to what is actually used that the concept of «saving memory» does not really make sense¹¹. In addition, there does not seem to be any accumulative property of brain activity. On the contrary, the opposite might be true¹², with individuals engaging in mentally demanding activities being more prone to undertake other intellectual challenges.

In the fifties, under the light of the latest developments of computer science, a view where the mind was an information processor and memory its data storage was popularized. This conception has however been abandoned as obsolete¹³ and it is now understood that memory is an intrinsic part of the thought process. Personal memory is, thus, much more than mere data storage. Very importantly, critical and creative thinking can only be performed with the information readily available as personal memory, as they are dependent on a holistic understanding of the subject at hand. A writer can only include a word that was previously unknown to him in a poem if he reads it first and understands it, even though he might have the whole dictionary lying next to his pen and paper. If there is a physical effect that will impact an engineer's project, he would only be able to take it into account if he learns about it and fully understands it, regardless of the information on the phenomenon being widely available on the internet. This is, external memory and personal memory are intrinsically different in the same way that information is intrinsically different from knowledge¹⁴.

In addition, memories are the basic building blocks for self-identity. This idea has been widely discussed in the scientific literature¹⁵. It has also been explored in the arts. In «*Do androids dream of electric sheep?*»¹⁶, the book that inspired the film «*Blade runner*», androids are given a set of photographs that articulate their life stories in order to give them an identity. In another film, «*Memento*»¹⁷, the plot follows a sufferer from retrograde amnesia, a condition which inhibits the formation of memories after a traumatic event. The movie shows his struggle to deal with daily activities and to find meaning. «*Black Mirror*», a British science-fiction TV series¹⁸, examines the possibility of keeping all memories with astonishing detail in an easily accessible high capacity record. However, contrary to what is portrayed there, memories kept externally do not contribute to our idea of self. They can be useful, bring to mind details that might have been forgotten or be a useful safety copy in case disease or age damage personal memory, but they cannot contribute to our identity simply because we can only have present what we already know.

¹⁰ BUSH (1999), «As we may think», *Library Computing*, 18(3), pp. 180-188.

¹¹ SAMUEL (1999): o. c.

¹² DONALD (1991): «An urgent matter of the mind». *The Globe and Mail*, Dec 26.

¹³ JOHNSON-LAIRD (1988): o. c.

¹⁴ FLORIDI (2009): «The Information Society and Its Philosophy: Introduction to the Special Issue on the Philosophy of Information, its Nature and Future Developments», *The Information Society*.

¹⁵ BLUNSTEIN (2008): *The moral demands of memory*. Cambridge University Press; MAGNUSSEN *et al*, «What do people believe about memory and how do they talk about memory?», *Everyday memory*, New York Psychology Press.

¹⁶ KIRK (1968): *Do androids dream of electric sheep?*. Doubleday Editions.

¹⁷ NOLAN, «Memento», film produced in 2000

¹⁸ BROOKS, «Black Mirror», TV series produced in 2011.

It is also important to note that the superposition of the personal memories of a society conforms collective memory¹⁹ and, with it, the collective identity of the peoples. It is common knowledge that collective memory often gets manipulated to serve a political role where it strengthens the power of the ruling authority²⁰. In particular, a skewed education has always been one of the most powerful tools when indoctrinating the masses, proving effective to create support to seemingly extremist views. In addition, political decisions are taken only in the light of the past experience that is actively remembered by decision makers. Historical records are useful only when have been studied and reflected upon.

In conclusion, it seems clear that the lack of necessity when it comes to memory results in a degeneration of the mnemonic abilities, and that this process is already underway in the general population. Given the implications that a reduced memory has on creative thinking and personal and collective identify, this should be a cause of concern.

3. ATTENTION ISSUES AND MULTITASKING

The way that ICTs shape daily and work activities has shifted focus from a sequential scheduling, where a new task is started only after the completion of the previous one, to a multitasking environment with a myriad of distractions. This constant information inflow, very often larger than the maximum cognitive load we can process²¹, so that the new data cannot be translated into conceptual knowledge. This data overstimulation, too fast to be deeply understood, is worrying. In this sense, attention and memory are closely related realities, with a high correlation between them. Data that are learned with a more intense attention focus tend to be recalled better and, conversely, memory exercises promote attention²². In addition, memory and attention are the essential factors of reflection, which is the essential ingredient for critical and creative thinking²³.

It can easily be seen that the hypertext structure of web content is fundamentally different to that of a book. It has been shown²⁴ that the way individuals scan websites is nothing but continuous: after probably reading the whole first paragraph, subjects start skipping text in a diagonal fashion. The study²⁵ provides with clues to take advantage of these findings to organize document structure so as to make it more efficient for advertising purposes. This scattered structure, together with the sometimes overwhelming number of interruptions (phone, email notifications, chat messages), results in a shattered attention.

It is necessary to distinguish between external and internal interruptions. External interruptions are out of the individual's control, like a phone call or an unannounced visit. Internal interruptions come from the individual himself and constitute the task switches that the subject chooses to perform, or intruding thoughts like involuntarily recalling a memory or compiling a mental list of things that need to be done. Similarly,

¹⁹ BLACKMORE, «High on technology- Low on memory: Cultural crisis in Dark City and the Matrix». *Canadian Review of American Studies*, 34(1), pp. 13-54.

²⁰ BLUNSTEIN (2008): o. c.

²¹ CART (2008): o. c.

²² CART (2008): o. c.

²³ VALKENBURG (2012): «Attention, Reflection and Distraction: The Impact of Technology on Learning», working paper.

²⁴ NIELSEN (2009): «Eyetracking Web Usability», New Riders Press, December 14.

²⁵ *Ibid.*

distractions are classified as active —such as singing or talking— or passive —such as listening to music—. Active distractions have been reported to cause more damage to attention than passive distractions²⁶. In addition, it has been shown that subjects who suffer more frequent external interruptions tend to experience more internal distractions as well²⁷, pointing to the fact that when attention is damaged the effect will be compounded by an increased inability to maintain focus.

Hallowell, as cited in Valkenburg²⁸, defines multitasking as a «*mythical activity in which people believe they can perform two tasks simultaneously*». Only a very reduced percentage of the population (2.5% according to Watson²⁹), known as «supertaskers» are able to undertake several tasks at the same time without any deterioration in performance. For the remaining population, it has been shown that multitasking results in a loss of efficiency of around 30%³⁰. In addition, paradoxically, it seems that chronic multitaskers have their performance affected even more adversely than the general population. They perform worse not only in attention tests, but also in the task-switching tests³¹. It seems, thus, that multitasking is an activity that we perform worse the more we exercise it.

It has been argued that the general population is increasing its IQ³², and therefore ICTs and other relatively recent lifestyle changes are having an either neutral or modestly positive effect on our cognitive abilities. However, as discussed in Valkenburg³³, this increase has been solely due to the improving scores in visual memory and tasks related to visual processing such as pattern recognition. This increase has overcompensated the declining scores in verbal comprehension and other related skills. The ability to pay attention to a text is deteriorating. We see better, but understand less.

As mentioned above, attention is necessary for reflection. There are already studies that link impulsivity as a personality trait to attention deficits. Within this context, reading would be associated with reflection and TCIs with impulsivity³⁴. The case of television is particularly interesting, with TV exposure considerably increasing the risk of children to suffer from Attention Deficit Disorders (ADD) in the future. In general, Hallowell has identified an «Attention Deficit Trait» in people exposed to multitasking. TCIs could be partly responsible for the spectacular rise in the number of diagnosed attention disorders.

As Nietzsche already expressed «*Nowadays everyone is like the travelers who get to know a land and its people from a train carriage*», as cited in Jackson³⁵. Widespread damage to our attention capabilities will result in a generalized impulsivity and a decline in creative and critical output. Damaging our ability to focus and reflect would result

²⁶ DZUBACK (2008): «Multitasking: the Good, the Bad and the Unknown», *Synergy: the Online Journal of the Association for the Tutorial Profession*. September. Retrieved from www.myatp.org/Synergy_1/Syn_6.pdf.

²⁷ OPHIR *et al* (2009): «Cognitive Control in Media Multitaskers», *Psychological and Cognitive Science*.

²⁸ VALKENBURG (2012): o. c.

²⁹ WATSON *et al* (2010): «Supertaskers: Profiles in extraordinary multitasking ability», *Psychonomic Bulletin & Review*.

³⁰ CRENSHAW (2005): *The myth of multitasking: How doing it all gets nothing done*. Jossey-Bass editions.

³¹ OPHIR *et al* (2009): o. c.

³² VALKENBURG (2012): o. c.

³³ VALKENBURG (2012): o. c.

³⁴ CHRISTAKIS (2004): «Early Television Exposure and Subsequent Attentional Problems in Children», *Pediatrics*.

³⁵ JACKSON (2009): *Distracted: The Erosion of Attention in the Coming Dark Age*, Prometheus books.

in inevitable damage to the high-level activities that we consider at the core of what it means to be a human being.

4. HAVE WE CREATED A «JUST GOOGLE IT» GENERATION? FURTHER DISCUSSION ON THE CONSEQUENCES OF THE FOURTH REVOLUTION

Since searching engines were introduced and internet connection became widely available, a large part of the population can access immediately not only raw data but also prepared solutions for common problems. Just typing the question on *google* or searching for a topic on *e-How* provides with easy step-by-step guides on issues from computer science to daily housekeeping. It is possible to log into forums and ask for advice on any possible matter, or perform a medical self-diagnosis just introducing our symptoms on a website. Even more importantly, social media sites and other web-based applications such as chats are increasingly becoming the communication channel of choice. Furthermore, the popularization of mobile internet devices is enabling all these activities anywhere, any time.

Therefore, independent problem solving and experimenting is becoming less frequent in daily life. Will the lack of practice, as seen in the cases of memory and attention, imply a degeneration of the ability? Will we be less able to deal with our problems on our own, or to keep in touch with our friends and family without the support of devices? Will we become dependent on them? It seems that this is already happening. Internet Attention Disorder (IAD) is being discussed for inclusion in the Diagnostic and Statistical Manual of Mental Disorders. Specific numbers on the incidence of this condition are difficult to assess given that objective diagnosis criteria are still missing. However, it seems clear that concerns are justified³⁶.

Another interesting aspect of the changes is that the use of ICTs at the workplace appears to have increased productivity as a whole. Communications got more efficient, and this resulted in the internationalization of businesses globally and in a dramatically increased flexibility for a vast proportion of jobs. However, some new problems have arisen in the current context. Feelings of isolation and stress are reported more frequently by workers who rely on ICTs more heavily for the undertaking of their daily activities³⁷.

Very importantly, some of the tasks that were once carried out by ordinary workforce have now been automated. Concerns about the damaging impacts of automation on employment, especially on unskilled labor, appeared with the First Industrial Revolution. Folk tales like the story of *John Henry* soon permeated into popular culture. John Henry is told to be a former African American slave working on the construction of new railroads in the United States. When a steam hammer machine was bought to work and the jobs of his coworkers were put at risk, he took a challenge to beat the machine with his hammer and physical strength. He won but, sadly, died of exhaustion soon afterwards. The story became an allegory of the tragedy of the machine versus man³⁸.

³⁶ BYUN *et al* (2009): «Internet Addiction: Metasynthesis of 1996–2006 Quantitative Research», *CyberPsychology and Behaviour*, 12(2).

³⁷ IPSOS (2008): «Workplace trends: Impact of Technology», Report prepared for Lexmark, November.

³⁸ GRIMES (2006): «Taking Swings at a Myth, With John Henry the Man», *New York Times*, Books section, October 18.

However, the tasks that were overtaken by machines at that time were only ones of a purely physical nature. As physical labor could be performed by animals too, the first Industrial Revolution did not really represent a threat to the core human competences, as all intellectual tasks had still to be carried out by men. This changed with the advent of the Forth Revolution³⁹. ICTs have effectively blurred the lines between the activities that can be performed by machines and the ones that can only be done by humans. Computers can read out loud, calculate integrals or play chess even better than their flesh-and-bone counterparts. What is more, the developments on Artificial Intelligence have somewhat been interpreted as a promise that machines will one day be able to everything we can and more. Transhumanists take this view to the extreme, anticipating a future where merging people and machines will open a universe of possibility and even the door of immortality⁴⁰.

Even just contemplating this possibility is unsettling as it blurs the definition of what it means to be a human being. Urgent reflection is needed. The authors propose that the core of what it really means to be alive, to be human, lays on abilities that cannot be objectively assessed, such as the possibility to create, take responsible decisions or to love another being. It seems reasonable that these higher level activities need other functions to support them. Machines might be able to perform these support functions as well, but efficiency aside they would miss their deeper dimension. These support functions should be considered equally human and in any case abandoned. The fundamentally different nature of these support functions when performed by humans should be acknowledged. They should be protected, for they construct the necessary base where everything else —our creativity, our independence, our identity— is built.

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³⁹ FLORIDI, «The fourth revolution», retrieved on 2013 Jan 13 on www.philosophyofinformation.net.

⁴⁰ Human+, Transhumanist magazine, www.hplusmagazine.com