

## IS INTERNET CHANGING OUR MIND?

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### SUMMARY

*In the last decades internet has transformed our way to communicate, relate and work. Probably it has already changed also the way of thinking, perceiving ourselves and reality. The increasing web-based social networking services is a striking feature of modern human society. Internet represents the real, extraordinary novelty of the third millennium and a large part of humanity is already online. Therefore, it can be postulated that the mind on the Internet will produce events and changes that we cannot ignore.*

**Key words:** internet – mind – psychiatry - genetic influence

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### INTRODUCTION

Socrates in Plato's dialogue Phaedrus, (about 370 BCE) discussed in concerns about writing. He expertly enumerated the reasons through which King Thamus refused the gift of the alphabet offered by Theuth. In this dialogue were present two opposing views: on one side there was the praise of Theuth, Egyptian God of arts and crafts, for his latest invention represented by writing. Theuth considered writing useful, a medicine of memory and wisdom. In contrast, Pharaoh Thamus was skeptical and rejected this gift. The Pharaoh was convinced that by writing our knowledge will no longer belong to us, because it will not be deposited in our minds or in our speeches, but it will be outside of us, on papyrus and in libraries. Writing was therefore rejected because it was dangerous for memory. The use of the alphabet could have promoted a hypocritical and superficial culture, because it did not arise from personal research work or teaching, but only from the summary collection of news and opinions written by others.

Later, writing as other new inventions, has profoundly changed the way to communicate, transmit values and relate ourselves. Plato did not yet know the existence of neurons and synapses but the concerns expressed at that time were precisely the changes that writing would induce in our mind. Today, the same concern is about how the invention and the use of the internet could change our mind (Pellegrini 2015). This work summarises the available literature that analyzed this topic.

### INTERNET AND ADOLESCENCE

Since the new technologies are available to children from birth, the most frequent question is if digital natives will be better adapted to the current world or if they will be individuals disconnected from reality with reduced cognitive abilities. Actually, there are not enough studies to answer.

During adolescence the human brain undergoes profound changes in both its structure and its function

(Blakemore & Mills 2014). Indeed, changes in brain structure, as measured by magnetic resonance imaging, appear to be under strong genetic control during the transition between late childhood and early adolescence. In addition, environmental influences, like internet use, would have little effect on adolescent's brain. Plasticity means the ability of the nervous tissue to modify its structure in relation to environmental stimuli. The brains change constantly in response to our experiences and behavior, reshaping their internal circuits to each sensory stimulus, motor act, mental association, reward, action plan or shift of the state of consciousness (Pascual-Leone et al. 2005). The plasticity of the brain tissue is manifested by a delicate dialogue between molecules, cells and the environment. The brain tissue of children is more sensitive, however plasticity does not stop in the first year of life; during adolescence the brain, especially the prefrontal cortex (Blakemore & Mills 2014), is still subjected to profound changes. Plasticity, although less marked, also exists in the adult brain and it is legitimate to ask what the effects of intensive internet use are on the synapses.

A cross-sectional survey conducted in China in 2009 analyzed the effects of Internet use on adolescents' lifestyles through a series of hierarchical regression analyses. The model showed that certain Internet habits, such as excessive online time, accessing the Internet in an Internet bar, and using the Internet for catharsis, were related to poor lifestyle habits in adolescents; on the other hand, using the Internet for purposes such as gaining knowledge and finding information positively predicted healthy lifestyles in adolescents and stimulated cognitive skills (Ligang et al. 2012). In addition, evidence increasingly suggested that time spent online did not displace time spent doing other activities associated with health and well-being. In particular, a recent longitudinal study of 14–24 year-olds found a positive correlation between moderate Internet use and participation in 'real-world' activities such as sports associations and participation in clubs (Romer et al. 2013).

## **INTERNET AND SOCIAL ACTIVITIES**

On the internet, many people compare their ideas, create information, discuss them and deposit images and videos on them. On the other hand, with internet use, contacts are maintained with people, new friendships are discovered and there are also those who fall in love. Today, social networks like Facebook and Instagram are promoters of all these functions.

The amygdala is a central structure in social cognition and it has been taken into consideration in different studies; indeed, an association between social network size and the amygdala has been demonstrated for real-world social networks. In detail, it has been shown that amygdala volume (corrected for total intracranial volume) positively correlated with the size and complexity of social networks in adult humans ranging in age from 19 to 83 years. This relationship was specific to the amygdala as compared to other subcortical structures. An exploratory analysis of the entire cortical mantle also revealed an association between social network variables and cortical thickness in three cortical areas, two of which share dense connectivity with the amygdala. Amygdala volume was not related to other social variables such as life satisfaction or social support. These findings converge with data from functional neuroimaging and lesion neuropsychology indicating that the amygdala plays an important role in brain networks contributing to social behavior (Bickart et al. 2011). Building on this work, two recent papers have shown that the amygdala's gray matter density is correlated with both online and real-world social network size (Kanai et al. 2012), and seems to increase in monkeys housed in larger social groups (Sallet et al. 2011). Obviously, is not possible to know if it is social relationships that widen the amygdala or if people with a larger amygdala enjoy more social relationships; there seems to be a biological correlate. The researchers extended their analyses to virtual relationships asking themselves if it was possible to measure if the same correlation existed between the amygdala and online contacts; another question was on how the amygdala reacted with Facebook contacts. According to research carried out by Ryota Kanai at University College London, there was a correlation similar to contacts in daily life. The researchers analyzed with the resonance magnetic the brain of 125 students active on social networks and compared the results with those obtained with the number of people really known by the subjects in real and virtual life (Kanai 2012). The first interesting result was that the volume of the gray matter of the amygdala has increased even in those who had an intense virtual life. There was also a second result: the volume of gray matter in three specific regions, medial left temporal gyrus, upper right temporal sulcus and entorhinal cortex, was greater in those who had an important number of virtual relationships. Also in this case it was not clear if the basic structure of the brain led to intense relationships also on social

networks, or if Facebook use modified the brain. It was instead safe, as happens in "real" life, that social networks had a shaping effect on our brain: receiving positive comments on Facebook activated an area of the brain, the nucleus accumbens, involved precisely in reward phenomena (Meshi et al. 2013), the same areas that play a role in the mechanisms of drug addictions. In 2012 Bickart et al., using resting-state functional connectivity magnetic resonance imaging (fcMRI), demonstrated that more socially connected people had brains characterized by stronger intrinsic connectivity between the amygdala and other brain regions subserving social cognition. They discovered that people who fostered and maintained larger and more complex social networks, not only had larger amygdala volumes, but also amygdalae with stronger intrinsic connectivity within two of these networks: one putatively subserving perceptualabilities and one subserving affiliative behaviors (Bickart et al. 2012). It can be postulated that variability in the size of online social networks has a neural basis. It has also been shown that for real-world human social networks, a significant amount of variability is accounted for by genetic factors (Fowler et al. 2009).

One method that has allowed us to use constantly internet is the increasing use of smartphones. Using smartphone, we can write messages, spend time googling, Facebooking, tweeting, posting, playing, accompanied by the continuous reports of WhatsApp. It is not a pastime, but it is a new way of life. Almost all young people between 12 and 19 years old own a smartphone and use it mainly to listen to music or surf the internet (Pellegrini 2015).

## **INTERNET AND THE "GOOGLE EFFECT"**

We use the internet to read the newspaper in the morning, watch movies in the evening, listen to music, buy books or clothes. We ask the internet for the meaning of words, the veracity of information, the quality of a hotel, the functioning of a camera, we ask the internet for the best route to follow by car and if a disease is serious or not. On the internet we buy tickets for concerts, pay invoices and we will soon express voting rights. For each specific theme, we can find original documents, films, insights that were once available to few people.

A Columbia University study claimed that having a search engine at your fingertips and neurons constantly allowed us to reorganize our way of thinking. According to this study, internet users remembered less and less "information itself", instead they remembered carefully where to find the information. This phenomenon, called the "Google effect", has also become a dilemma for teachers: it was once important to remember the dates of the Battle of Waterloo, which nations were present on the pitch, what determined that clash; for young people this information is now less important because they have it in their pocket (Sparrow et al. 2011).

Actually, using computer search engines to find information on the Internet has become a frequent daily activity of people at any age, including middle-aged and older adults. As a preliminary means of exploring the possible influence of Internet experience on brain activation patterns, Gary Small and colleagues performed functional magnetic resonance imaging (MRI) of the brain in older persons during search engine use and explored whether prior search engine experience was associated with the pattern of brain activation during Internet use. The authors studied 24 subjects (aged between 55 and 76) who were neurologically normal, of whom 12 had minimal Internet search engine experience (Net Naive group) and 12 had more extensive experience (Net Savvy group). The mean age and level of education were similar in the two groups. The results obtained from this research showed that while entering the words on Google, the two groups used two different brain regions: the Net Savvy group people activated the left lateral back prefrontal cortex; this region did not activate in Net Naive group people. Moreover, after a period of exercise spent researching online (one hour a day for five days), the same neuronal circuit was also activated in "beginners". These data suggest that Internet searching may engage a greater extent of neural circuitry not activated while reading text pages but only in people with prior computer and Internet search experience. On the other hand, in middle-aged and older adults, prior experience with Internet searching may alter the brain's responsiveness in neural circuits controlling decision making and complex reasoning (Small et al. 2009).

## PROBLEMATIC INTERNET USE

Many other studies have already highlighted the dangers of pathological use of the internet (addiction to games, sexual content or messages), with heavy behavioral consequences and with the appearance of brain mechanisms similar to those observed in drug addictions.

Problematic Internet use (PIU), which has become a global social issue, can be broadly conceptualized as an inability to control one's use of the Internet which leads to negative consequences in daily life. Disagreements regarding diagnostic criteria and the lack of large epidemiological studies have resulted in difficulties in establishing the prevalence of PIU in the general population. Several studies suggested high comorbidity rates between PIU and numerous psychiatric disorders highlighting the importance of focusing on comorbidity in treatment. Like for other pathologies (Juli et al. 2017), there is growing evidence that genetic, personality and individual differences in automatic and controlled aspects of self-regulation may promote the development of PIU. Pharmacological and psychotherapeutic treatments specific to PIU have received limited testing in large and rigorous studies. However, preliminary evidence suggested that both psychotropic medications (Escitalopram, Naltrexone and Methylphenidate) and

cognitive behaviour therapy may have some utility in the treatment of PIU. More research is needed on areas which remain unclear and contribute to the prognosis of PIU, in particular the temporal relationships between psychiatric disorder and PIU, mechanisms of comorbidity and the more subtle psychological changes that occur through Internet use (Spada 2014).

## DISCUSSION

Information technologies and the internet are helping us to organize, search and recover the result of our collective intellectual work on different scales, from Twitter to previews, e-books and online encyclopedias. Far from making us stupid, these technologies are the only things that can keep us smart. US psychologist Patricia Greenfield in *Science*, in an article where she analyzed more than 50 studies related to the effects of new media on neural dynamics declared that "each medium develops new cognitive skills at the expense of others": Indeed, staying on the computer, even for a video game, improves our space-visual intelligence, problem solving skills and gets us used to following multiple signals simultaneously (Greenfield 2009); playing online games would increase visual perceptual skills, visual memory and the speed of simultaneous processing of visual information (Green & Bavelier 2003); accessing websites would improve the ability to visually process information, while the use of emoticons would activate the front, lower right turn, a region that controls non-verbal communication skills (Yuasa et al. 2006).

## CONCLUSION

The cognitive level is not weakened but the cognitive activities have only changed. It is clear that as the alphabet given by Theuth to Pharaoh later became a cultural opportunity and not a tool that made us more stupid, internet has only reorganized the way thereby we access information.

To date, there are few elements that indicate an obvious change in brain tissue following the use of the internet, both because of the objective difficulties of being able to measure an effect (methodological problems) and because research has failed to highlight important changes (Mills 2014). The questions that remains to be answer are different: how is it possible, for example, to measure the effect of internet on brains that come from diversified socio-cultural paths? will we become more superficial, less reflective, always distracted by the continuous notifications of the messages we receive? And what does it mean to relate more and more through a screen?

Even, we can imagine new forms of amnesia due to the absence of a network, or Alzheimer's forms due to hard disk failure, or confusion due to loss of the agenda and phone numbers on smartphones. All situations that we have already partially experienced every time that the "mobile phone doesn't take" or skips internet connection.

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