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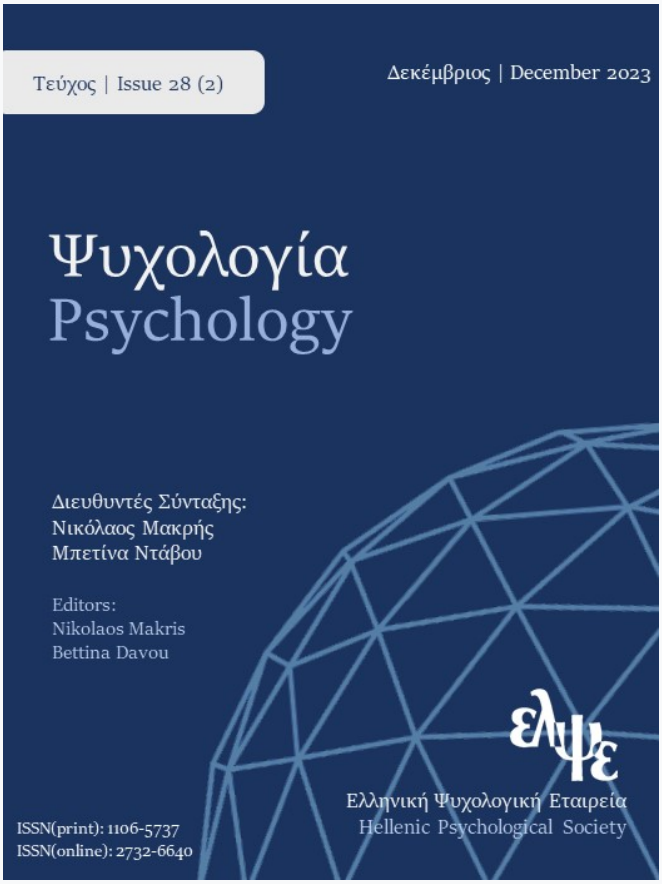

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The mind online: Can digital technologies affect how we think?

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ABSTRACT

The internet and its applications have changed how we seek, process and share information. The paper addresses the question of how the digital expansion of the mind can affect cognition and has two key aims: The first is to explore whether and how our cognitive processes differ when we are online and when offline. The second is to focus on the impact of digital technologies on human attention, memory, decision-making, and problem-solving. We attempt to explain and discuss phenomena, such as multitasking and task switching, use of the internet to support and extend our memory, the development and use of a variety of heuristic-based strategies to search for information online, and making judgements about the credibility of information, among others.

Introduction

“Where is the knowledge we have lost in information?” (Eliot, 1934, p. 7)

During the last half-century, from October 1969, when the first connection was made between two computers at UCLA and the University of Utah, to January 2023, when 5.16 billion people use the Internet (DataReportal, 2023), but especially during the last two decades, we have witnessed the impressive and rapid penetration of Internet access. In addition, new digital technologies, like the Internet of Things, big data analytics, and Artificial Intelligence, are becoming widespread and affecting various aspects of people's lives. These advancements can potentially transform people's interactions, lifestyles, work, and leisure activities, both now and in the future.

One of the most impactful changes that the Internet has brought to our lives is instant access to vast information. The previous sentence's most critical and exciting point is the "instant" access and not so much the amount of information. Humans have always had access to more information than they could manage. Still, digital media have brought about a fundamental shift by enabling anyone with a computer or a portable device to quickly access and participate in an almost limitless exchange of information.

A second crucial difference is the speed at which changes occur in the digital world. Driven by rapid technological disruptions, the pace of change in the world is faster than ever (Lee, 2020), and even those considered experts today may need help to keep up with the latest advancements tomorrow.

This new reality has apparent effects on human cognition, or at least on some of its systems. However, it is one thing to talk about the effects and another to argue that digital technologies will change how we think. Throughout history, advancements in technology have transformed human interaction with the world. The evolution of tools, language, industrial machinery, and digital technology has moulded our minds and societies. However, this is an evolutionary process in which humans adapt to digital technologies and technologies adapt to them (Heersmink, 2016). Until recently, the adaptive value cognitive mechanisms have in the functional economy of the organism has been underestimated (Lyon et al., 2021); the human brain is the source of behaviour, yet at the same time, it is modified by the behaviours it generates (Wang et al., 2017).

The effects of the Internet on our cognitive processes remains a research area in which little progress has been made, at least compared to the noise generated in recent years by several books and articles (Carr, 2010; Greenfield, 2015; Small et al., 2009), which target the fears of digital immigrants, the concerns of parents, and the disparaging emotions of all those who feel that our world as we know it is headed for annihilation.

The paper's focus is to examine the influence of the digital realm on various cognitive processes such as attention, memory, problem-solving, and decision-making. Throughout the paper, various phenomena related to the use of digital technology are discussed in relation to their impact on the mind. This includes the effects of multitasking and task switching, using the internet to enhance memory, utilising heuristic-based search strategies while navigating the web and assessing the credibility of information obtained online. The selection of topics is not exhaustive and only encompasses some possible subjects. Instead, the focus is on those areas for which there is a significant amount of literature that the author considers to be of utmost importance and for which our Experimental Psychology Laboratory is already conducting or planning experiments.

Attention, multitasking, and task switching in the digital environment

The evolution of the Internet into a digital environment in which users seek information, communicate, and make decisions, the diffusion of larger screens supporting multiple windows and applications, the increasing availability of portable media coupled with social and work expectations of immediate responsiveness, and the integration of the digital environments into our daily routines through a variety of smart devices have transformed our personal, work, and social environments. They have also given way to frequent interruptions and plenty of distractions that emerge from both our inner and outer worlds. Information overload within online environments presents a challenge to users' ability to concentrate and allocate their attention efficiently (Kozyreva et al., 2020). People's ability to sustain their attention focused on a cognitive task is compromised by distracting notifications calling constantly for attention and the appealing, addictive, and distracting design of various Internet applications (Gazzaley & Rosen, 2016).

Networked digital technologies provide us with so many varied rewards (of informational, entertainment and even social nature) that we create habits which dominate the cognitive function of attention but also reshape it so that it can respond to the unique demands of the digital environment (Harley, 2022).

An interesting finding by Sanbonmatsu et al. (2013) links the inability to block out distractions and focus on a single task with the tendency to multitask. We are now constantly online, texting, reading, and using social media while performing other highly demanding cognitive tasks. Students report that "they do not turn off devices or stop texting and using social media even while attending class or doing homework" (Bellur et al., 2015, p.67). Multitasking, a commonplace activity to deal successfully with the competing demands of digital environments (Harley, 2022), can be seen as disrespectful and inappropriate behaviour, particularly during lectures, in-person or remote meetings, where it may signal a lack of engagement (Cao et al., 2021). A few recent papers (e.g., Adler & Benbunan-Fich, 2012; Alzahabi & Becker, 2013; Popławska et al., 2021; Wiradhany & Nieuwenstein, 2017; Yap & Lim, 2013) have suggested that media multitasking –i.e., using multiple media channels simultaneously on different or a single device– can be cognitively effective.

However, many more studies have reported negative associations between media multitasking and cognitive skills. Results from two experiments conducted by Ward et al. (2017) indicated that even when users avoid the temptation to check their mobile phones and maintain sustained attention, the mere presence of these devices negatively affects cognitive functioning, specifically available working memory capacity and functional fluid intelligence. Lang and Chrzan (2015) analyzed twenty studies published since 1990 which compared performance in single and multitasking conditions, where at least one of the tasks was a media use task. They report that in ten out of thirteen studies which used a post-task memory accuracy test about information presented in a single or multitasking condition the single-task condition was better. Similarly, the single task condition was better when the accuracy of the primary task was used as the performance measure, and in four out of nine studies the single task condition was better when task completion was measured (the rest five studies did not find any difference between the two conditions).

According to a recent meta-analysis by Clinton-Lisell (2021), multitasking while reading is an inefficient practice. It impairs reading comprehension when time is constrained and extends the duration of the reading task when readers can regulate their reading speed. Notably, multitasking has a more pronounced negative effect when reading from traditional paper sources compared to digital screens, which carries implications for educational practices in an increasingly digital world.

Two opposing hypotheses have been proposed to explain the impact of media multitasking on attention (van der Schuur et al., 2015). The trained attention hypothesis claims that multitasking can improve certain control processes, such as task switching (Alzahabi & Becker, 2013) and filtering irrelevant information (Cain & Mitroff, 2011). In contrast, the scattered attention hypothesis claims that heavy multitasking may affect control processes in the long term. Ophir et al. (2009) reported a few experiments, the main finding of which was that users who frequently engaged in media multitasking exhibited a different approach to fundamental information processing activities than those who are light media multitaskers and, surprisingly, performed worse on a task-switching ability test. Specifically, they had poorer capacity to filter out information that was irrelevant to the tasks they performed, were less likely to ignore irrelevant representations in memory, and were less effective at preventing the activation of irrelevant task sets. Ophir et al. (2009) argue that the difference between the two groups is rather a matter of orientation: Heavy media multitaskers have a greater tendency for bottom-up attentional control and a bias toward exploratory information processing, sacrificing performance on the primary task to let in other sources of information. On the contrary, individuals who engage in light media multitasking are more prone to top-down attentional control, making it easier for them to concentrate on a single task even when faced with distractions.

Users' perceived efficiency is one of the main reasons they engage in multiple attention-demanding tasks simultaneously (May & Elder, 2018), but research evidence suggests that users exhibit a tendency to overestimate their multitasking ability (Sanbonmatsu et al., 2013).

Is media multitasking the simultaneous performance of tasks, or does it involve switching between them? The answer to this question is not straightforward. There are cases where the tasks cannot be performed without switching. For example, when the tasks are performed on the same device and require the user to alternate between them, or when the cognitive tasks require the same perceptual mechanism or the same processing system and, therefore, must be processed or perceived in a sequential manner. On the other hand, you can have a videoconference playing in the background while you do other things and just listen for important points; apparently, a coping mechanism used by many of us during the COVID-19 pandemic simply because the need for synchronous collaboration in the absence of in-person interactions led to too many remote meetings (Cao et al., 2021).

Only a few studies have been conducted over the last years on the neurophysiology of media multitasking. Loh and Kanai (2014) conducted a study to investigate the relationship between media multitasking activity and brain structure variability. The results revealed a negative correlation between media-multitasking scores and grey matter density in the anterior circulate cortex (ACC), which is a frontal lobe structure involved in executive cognitive control and has been implicated in situations where individuals are confronted with competing stimuli and responses associated with two or more tasks. Loh and Kanai's study extended the literature which suggests that heavier media-multitaskers show poorer cognitive control abilities but similarly to previous research attempts they failed to determine the direction of causality. In other words, these findings cannot rule out the possibility that individuals with smaller ACC engage in multitasking due to their weaker skill to exercise cognitive control.

Moisala et al. (2016) utilized fMRI to assess brain activity in 149 adolescents and young adults as they classified written sentences as congruent or incongruent while also being exposed to distracting speech or music or as they classified spoken sentences while being exposed to distracting written text. The results showed that in the presence of distractor stimuli, self-reported amount of media multitasking in everyday life correlated positively with brain activity in right dorsolateral and dorsomedial prefrontal cortical regions, which are areas involved in attentional and inhibitory control. Moisala et al. (2016) argue that one interpretation of this finding is that the higher the media multitasking score of the individual, the more effort (attentional top-down control) must be expended on the individual's part to focus on a focal task in the presence of a distractor.

Finally, Kobayashi et al. (2020) studied the relationship between media multitasking and functional connectivity in the dorsal attention network (DAN), which is a network of fronto-parietal cortical areas activated during attention tasks, and responsible for focused attention and goal-directed top-down attentional processing. They found that, during resting state, participants exhibited higher connectivity scores in the DAN than during a task that demanded focused attention. The reduction of connectivities is a crucial ability for engagement in cognitive tasks (Tomasi et al., 2014) and it has been claimed that smaller differences in connectivity patterns from resting state to task state are associated with improved cognitive performance (Schultz & Cole, 2016). In addition, connectivity score reduction from resting to task was attenuated in higher multitaskers compared with lower media multitaskers; a result that supports the trained attention hypothesis. Besides, even though brain-

imaging studies are still very few, they all seem to agree that the effects of heavy media multitasking on cognitive skills are mediated by effects on brain areas involved in executive cognitive functions.

In conclusion, there is plenty of evidence that frequent media multitasking has detrimental effects on attention. According to the findings of behavioral and brain-imaging studies, heavy media multitasking may lead to enhanced distractibility and serious problems in maintaining attention. On the other hand, multiple tasks present greater opportunity for rewards than singular tasks and we should accept that multitasking is "the new normal" (Courage et al., 2015), and we will hardly change this. Therefore, research needs to focus on how users could benefit from this process. It is important to keep in mind that multitasking can be more efficient when there is a relationship between the activities performed by users as well as when the secondary task has a high level of social accountability (Angell et al., 2016). Finally, digital technology could assist users in curbing unwanted behaviors (Popławska et al., 2021); plenty of applications can monitor and regulate task and self-interruptions.

Accessing and storing information

How did humans find information before the Internet? Older readers may answer that we could ask someone knowledgeable about the subject or look for the information in an outside source, for example, an encyclopedia or specialist book. Today we have constant access to information, provided we remain plugged into the Internet. Sparrow et al. (2011) have been some of the first to argue that human memory processes are adapting to the advent of ICT and the use of online search engines, such as Google, as an external memory system that can be accessed at will. The results from four experimental studies they conducted suggested that a) when people are faced with difficult questions, they are primed to think about computers, b) when they expect that they will have access to information, they put less effort into encoding it internally, c) when they believe they will not have access to a piece of information in the future, memory is enhanced for the information itself, and d) when they anticipate that information will always be readily accessible, as is typical with Internet access, they tend to recall the source of information than the item's specifics (Sparrow et al., 2011). Much discussion has taken place on these findings, and participants' impaired performance when told that the computer would save the information compared to the condition where they were told that it would be erased has been called the Google Effect. However, it should be noted here that Sparrow et al. did not use a search engine (or Google) in their experiments, but the information stored in folders on the hard drive of a computer in their lab. The specific characteristics of their experiments are considered by several researchers an important limitation and perhaps the reason why their findings have not been replicated by more recent research (see Marsh & Rajaram, 2019 for a review).

We may have known since the middle 1950s that the span of short-term memory is between 5 and 9 items of information (Miller, 1956), but people have always used external aids to increase this capacity. None of us would go to the market having memorized the 15 goods we needed, but we would write them down on paper. The concept of the extended mind posits that the mind extends beyond the brain and operates in an interconnected system with the environment. According to Clark and Chalmers (1998), an extended cognitive system is anything external that helps perform a task that would otherwise be done internally by cognitive processes. The Internet and its applications, along with the devices we use to take advantage of its potential, offer a fascinating and innovative way of externalizing information. They go beyond just aiding memory, as previous media have done, and play a significant role in storing and accessing memories (Barr et al., 2015).

Using external resources to extend the abilities of human memory is not new (Storm & Soares, 2022) nor is the fear that relying upon those resources will have deleterious consequences for the way people store information and think. In his dialogue "Phaedrus", Plato puts Socrates to narrate a short myth in which the Egyptian god Theuth presents his invention of writing to King Thamus for distribution to the people of Egypt. Theuth boasts of writing as a remedy for memory, but Thamus replies that the true impact of writing is likely to be the exact opposite:

> *"It will atrophy people's memories. Trust in writing will make them remember things by relying on marks made by others, from outside themselves, not on their own inner resources, and so writing will make the things they have learnt disappear from their minds. Your invention is a potion for jogging the memory, not for remembering. You provide your students with the appearance of intelligence, not real intelligence. Because your students will be widely read, though without any contact with a*

teacher, they will seem to be men of wide knowledge, when they will usually be ignorant. And this spurious appearance of intelligence will make them difficult company." (Plato, 2002, p. 69)

The Internet is not only an external mnemonic system, such as a notebook or a recording; it is much more dynamic and also acts as a form of transactive memory (Atkinson & Barker, 2021; Sparrow et al., 2011). When Wegner (1987) envisioned transactive memory, he described an external memory mechanism through which groups collectively store knowledge. As such, the Internet reduces the allocation of cognitive resources towards the process of storing the information and the ability to recall specific details of the information stored externally (Firth et al., 2019). Transactive memory is mainly semantic, but it could be also linked to procedural memory depending on where memories are stored and when and how quickly they are retrieved (Atkinson & Barker, 2021).

Until a few years ago, humans used different external mnemonic systems to search for information of a different nature: If you needed help to prepare dinner, you would find it in your grandmother's recipe cards, whereas if you wanted an expert's advice on choosing a new Hi-Fi system, you would ask your friend who you knew was an expert in audio systems. Transactive mnemonic systems have significant advantages and obvious weaknesses: No matter how good a cook your grandmother is, if for any reason she is unavailable, her knowledge and skills are useless to you. Today, the Internet continuously gathers all human knowledge and, in fact, not only semantic, but also a growing part of episodic and procedural information, leading humans to offload responsibility for the majority of information to the web (Ward, 2013). In this way, the amount of information that individuals store internally is reduced, simply because, when presented with new information, people's first impulse is not to store this information in their memory, but to let it pass them by, with the assumption that it will be "remembered" by the Internet. However, it is important to note that the cognitive process of memory is not limited to the retention and storage of information but has an integrative nature that allows humans to understand the relations between different items of information and build up knowledge. This is a very different process from the automated information management functions used by search engines or social networking applications, and of course the more we rely on the organization these applications produce for us, the less understanding we have of their content. Using the Internet as a transactive memory system also has positive consequences: while it gives us access to an unimaginable amount of information, at the same time it is offered with minimal mental effort, allowing the mind to focus on processing information rather than searching for it (Sparrow et al., 2011).

Since the early 1990s, when the first Internet search engines appeared, we have become dependent on the devices we use to access information. Experience with Internet searching tasks may alter the brain's responsiveness in neural circuits controlling higher cognitive processes. For example, a study with middle-aged and older adults by Small et al. (2009) has indicated that searching the web for information is more stimulating than reading. In addition, the group of participants with extensive Internet search engine experience demonstrated significant increases in signal intensity in brain regions controlling decision-making and complex reasoning compared with the group with minimal experience.

Storm et al. (2017) reported a series of experiments demonstrating that using the Internet as an information source increases users' tendency to do the same in the future. Specifically, participants who used Google to answer a set of difficult questions were more likely to use Google to answer a set of relatively easy questions compared with participants who answered the first set of questions from memory. Similarly, Wang et al. (2017) have showed that people are easily dependent on the Internet search engines. In a study which involved six days of training on Internet search, participants showed higher brain activations in dorsolateral prefrontal cortex (it suggests more endeavors engaged in impulse control) and anterior cingulate cortex (it plays a critical role in regulating and monitoring behaviors) in the post-test than in the pre-test. Their findings suggest that the post-test elicited more search impulse than pre-test when facing unknown questions. In addition, there were significant positive correlations between self-reported search impulse and brain responses in the frontal areas.

In a series of nine online experiments, Fisher et al. (2015) showed that searching the Internet for answers leads seekers to an illusion of knowledge. In other words, externally accessible information is confused with one's personal knowledge. The participants who had used a search engine to look up explanations on several domains gave themselves better ratings of their ability to answer the questions than those who had not used it. Similarly, in another experiment, Fisher et al. asked the participants to use a scale of seven fMRI images of varying activation levels; those who had used the search engine chose images with more brain activity corresponding to higher quality explanations while answering unrelated questions. This effect was not the result of general

overconfidence or misinterpreting the dependent measure but was directly caused by their use of Internet search engines to obtain information. Fisher's et al. (2015) results suggest that searching the Internet may cause a systematic failure to recognize the extent to which humans rely on outsourced knowledge and inflates self-assessed knowledge in unrelated domains.

The Internet and its applications are much more than an information storage. The scant research effort that has been made in recent years to study research questions about the Internet's effects on human memory does injustice both to the Internet and to the diverse ways in which its users use it to perform a multitude of cognitive tasks. There is unanimous agreement among researchers on shifting the focus from simply studying the Internet as a repository of memories to encompassing a more comprehensive range of inquiries related to cognitive processing. Marsh and Rajaram (2019), for example, list several critical questions such as exploring whether Internet use becomes habitual, investigating when and under what circumstances the Internet encourages superficial information processing, understanding the extent to which Internet usage necessitates a different kind of metacognitive awareness, exploring how the Internet's effects on social connections interact with cognitive processes, examining the Internet's role as a source of misinformation and its potential consequences, and investigating the Internet's influence on autobiographical memory and its implications, along with the question of whether it enhances or hinders information appropriation.

Searching for information online and judging its credibility

One of the most significant changes that the Internet has brought to our lives is instant access to a vast amount of information of every nature. With so much information available, it can be overwhelming for users to sift through and find reliable information. This new reality created a need for new skills, or at least skills that did not matter as much in the pre-Internet era. These skills are related to searching for, evaluating, synthesising, and using information in the digital world. One of these complex cognitive skills is information problem-solving or information literacy. The critical characteristics of information literacy are recognising when we need information and locating, evaluating, synthesising, and using the required information effectively (Association of College and Research Libraries, 2000). Finding the correct information on the Internet has become an essential cognitive skill for ICT users.

Over the last half-century, a considerable body of research in cognitive psychology documents the fact that humans tend to be "cognitive misers" (Kahneman, 2011; Stanovich, 2021). "As a rule, people tend to use mental shortcuts in making judgments and drawing inferences" (APA, 2015, p. 205). If we were to select one area of human behaviour where cognitive miserliness would be more characteristic, it would be none other than information problem-solving.

A relatively common finding of the numerous papers that have been published regarding the quality of search behavior and strategies is that information problem solvers seek out quick, adequate solutions to problems by using general-purpose search engines such as Google but rarely select advanced search options failing to make the most efficient use of them (Weber et al., 2019). Specifically, they have not planned a strategy before engaging in a search (Roscoe et al., 2016), they formulate short and simple in structure queries (Vezzosi, 2009), they rarely construct complex Boolean ones (Li et al., 2017), and they view very few result pages (Spink et al., 2001). Furthermore, a high percentage of search strategies (over 90%) contain various types of errors influencing the conclusions of the searches (Salvador-Oliván et al., 2019). Users' lack of strong digital information literacy skills (van Deursen & van Diepen, 2013), complexity of the information problems to be solved (Monchaux et al., 2015), and prior domain knowledge (Willoughby et al., 2009) appear to be major predictors of performance in online information search.

Although most of the information is accurate and extremely useful, much of it is inaccurate, untrue, incorrect, or misleading. In some cases, it can even be manipulative, influencing public opinion (Pennycook & Rand, 2021) and public health (Swire-Thompson & Lazer, 2020), education (Kendeou et al., 2019), and business (Petratos, 2021).

In the age of the Internet, the way in which we view, consume and assign trust to information is changing. Making judgments about the credibility of information is certainly not a new skill, but it has become increasingly important today. Evaluating information credibility has always been an essential aspect of critical thinking and research (Carlson, 1995). In the pre-Internet era, authors and journalists, news producers and directors, peer reviewers and academic journals, editors and publishers, librarians and information specialists played a crucial role in ensuring that information was trustworthy and met certain standards before it was disseminated to a

wider audience (Pearson & Kosicki, 2017). However, today anyone can have a voice on the Internet, and it has never been easier to publish information, irrespective of the expertise of its author. It is extremely easy to create fake websites and social media accounts and to manipulate information to fit an agenda. In contrast, the lack of accepted protocols for regulating the flow of information into the online domain means an abundance of information available, not all of which is accurate or reliable. Additionally, the fact that part of it lacks authority indicators, such as the identity, the level of expertise, or the reputation of the source (Metzger & Flanagin, 2013), can make it challenging to distinguish credible sources from unreliable ones (Hadlington, 2017). Therefore, it has become more essential than ever to be able to evaluate the credibility of online information.

The skills required to evaluate the credibility of online information include critically evaluating the nature and source of information, using multiple sources, possessing contextual knowledge, functional skills, and knowledge about the Internet together with knowledge about the broader digital environment (Polizzi, 2020). Additionally, recent research (e.g., Metzger et al., 2010) suggests that information seekers tend to minimize cognitive effort by applying several cognitive heuristics linked directly to the assessment of credibility. Such heuristics are the reputation (relying on the reputation of the source), the endorsement (accepting a source if others also do), the consistency (cross-validating information for consistency), the expectancy violation (considering how well the source aligns with expectations of trustworthy information), and the persuasive intent heuristics (identifying commercial motivations as negative heuristic cues for a credibility judgement; (Metzger et al., 2010). Although these processes can serve information seekers well in many cases, they are far from perfect and can often be influenced in ways that lead them to believe that information is credible when indeed it is not. For example, users may inappropriately confuse credibility with popularity, or discount information as not trustworthy simply because it disconfirms the user's own opinion (Metzger et al., 2010).

The skills mentioned above serve the demands of a digital environment in which users must constantly make almost countless decisions. However, the number of decisions required by the users is not the most impressive characteristic of this new situation. The digital media we use increasingly use advanced analytics, automation, and machine learning to act as delegates and aids in decision-making (Chugunova & Sele, 2022). This can enhance problem-solving abilities and lead to faster and more accurate decision-making. Still, it also can raise questions about the transparency of the decision-making process and the potential for bias in intelligent algorithms.

There has been a lot of discussion over the last twenty years, both in mainstream media and scholarly journals, about the idea that these algorithms mainly expose us to information that aligns with our existing views, creating a biased and unbalanced flow of information and limiting our ability to consider different perspectives and make well-informed decisions. The "filter bubble", introduced by Pariser (2011), is the idea that search engines and social media, with their recommendation and personalization algorithms, foster confirmation bias and segregation and contribute to societal and ideological polarization. This comes at the expense of the quality of the information and leads to the proliferation of biased narratives fomented by unsubstantiated rumours, mistrust, and paranoia (Vicario et al., 2016). The filter bubble has been blamed for the rise of populist politicians, with search and social media companies receiving criticism for allowing their creation (Fortunato & Pecoraro, 2022; Gal, 2021). However, there is limited proof of the filter bubble's existence or the related concept of "echo chambers" (a term introduced by Sunstein [2001]). Instead, frequent use of the concept has created its own reality that affects society, media, platforms, and users. Bruns (2019) warns that this focus on the filter bubble may distract from more important questions like why groups have different interpretations of information and how to prevent the solidification of these into partisan identities. In fact, search and social media users tend to have a more diverse and centrist media diet than non-users (Fletcher & Nielsen, 2017, 2018; Silver et al., 2019).

Lack of understanding about algorithmic curation results in a missing crucial view into what affects the content seen in search results and social media feeds. This lack of understanding undermines an individual's ability to make reasonable evaluations about the information they are exposed to. Additionally, it prevents individuals from adjusting their intake of information and responding to it appropriately. As a result, disparities in algorithmic knowledge create a divide between those who are capable of examining and evaluating algorithmic portrayals of reality and those who may unconsciously accept them as normal (Carmi & Yates, 2020).

The topics addressed in this section (information problem solving, credibility assessment, algorithm awareness) and the conclusions from the relevant research raise a critical question: How can we cultivate expertise in information problem solving? This is a vital inquiry since the ability of students to effectively manage information is crucial at all levels of education. Despite this, most studies indicate that these skills are frequently lacking. It is often assumed that students will automatically develop into expert problem solvers through their frequent utilization of the Internet and its various applications. However, research has shown that this

assumption is not entirely accurate (Weber et al., 2019). On the contrary, it is a skill that can be developed and improved with practice (e.g., McGrew, 2020).

Discussion

In the three sections of the present paper, some significant differences emerged between the digital and real worlds. The digital reality we encounter daily still differs from the physical world in many ways. First, we have immediate access to unimaginable information in the digital world. Even if it were available in the physical world, it would only be possible to locate and retrieve it with technological tools. With information and communication technologies integrated into our lives, the Internet and its applications have become very good at capturing our attention and changing how we find, evaluate, and use information. This review shows evidence supporting several ideas about how the Internet is affecting our brains and thinking processes. The constant flow of information online encourages us to switch our attention often and multitask instead of focusing on one thing. Online access to information also competes with traditional learning methods and may affect our memory. Much of this information lacks the credibility that real-world information has, such as that derived from indications of the source or author. The availability of the Internet as a constant source of information may lead to a new form of intelligence characterized not by inherent knowledge but by the capability to locate and utilize information through cognitive abilities.

The idea that knowledge is increasing at an unimaginable rate and is now impossible for humans to control is hard to grasp. However, this is a reality that does not change if we pretend not to see it and requires a concerted effort on our part in three directions:

Digital literacy

How far are we from the day when we can ask our mobile or wearable devices natural language spoken questions and receive spoken answers? For example, in 2018, Amazon introduced the Alexa feature called “Remember This”, which allows users to save memories (Atkinson & Barker, 2021). Thus, you can say “Alexa, remember that I have to submit the X paper to Z journal on the 10th of February” and a few days later ask her “Alexa, when is the deadline for the submission of paper X?” Furthermore, it is certain that in the coming years applications will be available that will allow instant access to information in ways that do not require conscious search on the part of the user but will be related to their actions or even their thoughts. We are also moving steadily toward the implementation of technologies that revolve around and within our brains and our bodies, as evidenced by the development of various devices and systems, such as neuroprosthetics (for a discussion on the different types of neural prosthetics and their ethical aspects see Glannon, 2022).

The ability to effectively navigate, evaluate, compare, and synthesize information found online is becoming increasingly valuable in our information-based society, sometimes even more so than having a lot of facts stored in biological memory. This is partly because utilizing the Internet as an external memory system provides numerous benefits in areas such as academic research, education, navigation, and journalism (Heersmink, 2016).

Given the rapid advancements in technology and the growing influence of tech giants in all aspects of society, it is crucial to create digital literacy programs that ensure the inclusion of people in a data-driven world. However, there is also a need for increased public scrutiny, critical evaluation, and proactive measures to hold technology accountable and prioritize people over profit rather than accepting a tech-focused narrative.

Ethical boundaries

The need for constant vigilance and the establishment of clear guidelines and regulations to protect users’ privacy and security, immunize them against common ways of disinformation and manipulation, and promote ethical behaviour when using digital technologies has never been greater. At the end of November 2022, when these lines were being written, ChatGPT (2022) was released and immediately became a global phenomenon. ChatGPT is an artificial intelligence (AI) language model developed by OpenAI and trained on a large corpus of text data to generate human-like responses to various questions and prompts. It can converse, answer trivia questions, and provide information and insights on various topics. ChatGPT’s popularity came as a shock but also caused controversy because there have been complaints for incorrect, biased or fictional answers, fears for A.I.-generated student work, and concerns about its use for spreading fake information. When asked by this author

how it responds to the heavy criticism of its use and dangers to education, marketing and politics, ChatGPT responded as follows:

> *"As a language model, my primary function is to assist users in generating human-like text. While it is true that some people may use my capabilities for unethical or fraudulent purposes, it is important to remember that the responsibility for these actions lies with the individuals who use me in that way, not with the technology itself. Additionally, it's important to note that language models like me are not a replacement for education, critical thinking, or human creativity. I can assist in the writing process, but ultimately it's the user who must take responsibility for the final product. Furthermore, it's not only the responsibility of the users, but also the responsibility of the educators, politicians, and business leaders to develop strategies to prevent misuse and to educate people on how to use language models ethically" (Personal communication, January 2023).*

Future research

Research should move away from simple questions such as how the Internet affects human cognition to a more in-depth examination of how internal processes and external digital tools interact. It is crucial to recognize that the Internet and digital technologies are just means, and it's up to researchers to study how they can be utilized to expand, not limit the human mind.

There are also several areas in need of further exploration. For example, the impact of the Internet on different stages of cognitive development (e.g., the child, the adolescent, and the ageing brain) and its long-term effects have yet to be empirically investigated (through longitudinal studies ideally).

A significant problem when studying cognitive processes in the digital world and the consequences of ICT on how people think is that there is often a mismatch between how researchers study mental processes and how those processes function in everyday life. Cognitive processes will need to be studied at the level of individual participants in controlled laboratory environments and in the context of the various cognitive technologies and devices they interact with. These tools have the potential to both aid and modify cognition and behaviour in multiple ways, and future studies must consider this. Indeed, the interaction of the mind and technology could become so ubiquitous that it may, in many ways, become inappropriate or even misleading to consider the functioning of the mind in the absence of technology.

The constant evolution of digital technologies adds a layer of complexity to the already complex study of the issues covered in the present paper. The digital world of the future is expected to be vastly different from what it is today. This unpredictability makes it difficult to study and fully comprehend the various questions related to digital technologies. This, in turn, results in a constant state of change and uncertainty in digital studies.

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ΒΙΒΛΙΟΓΡΑΦΙΚΗ ΑΝΑΣΚΟΠΗΣΗ | REVIEW PAPER

Ο νους στο διαδίκτυο: Μπορούν οι ψηφιακές τεχνολογίες να επηρεάσουν τη σκέψη μας;

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ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ

Νους,
Διαδίκτυο,
Γνωστικές διεργασίες,
Προσοχή,
Μνήμη,
Λήψη αποφάσεων

ΣΤΟΙΧΕΙΑ ΕΠΙΚΟΙΝΩΝΙΑΣ

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ΠΕΡΙΛΗΨΗ

Το Διαδίκτυο και οι εφαρμογές του έχουν αλλάξει τον τρόπο με τον οποίο αναζητούμε, επεξεργαζόμαστε και μοιραζόμαστε πληροφορίες. Η παρούσα εργασία εξετάζει το ερώτημα πώς η ψηφιακή διεύρυνση του νου μπορεί να αλλάξει τις γνωστικές διεργασίες και έχει δύο βασικούς στόχους: Ο πρώτος είναι να διερευνήσει εάν και πώς διαφέρουν οι γνωστικές μας διαδικασίες όταν είμαστε συνδεδεμένοι και όταν βρισκόμαστε στον πραγματικό κόσμο. Ο δεύτερος είναι να εστιάσουμε στον αντίκτυπο των ψηφιακών τεχνολογιών στην ανθρώπινη προσοχή, τη μνήμη, τη λήψη αποφάσεων και την επίλυση προβλημάτων. Θα προσπαθήσουμε να εξηγήσουμε και να συζητήσουμε φαινόμενα, όπως η πολυδιεργασία και η εναλλαγή εργασιών, η χρήση του διαδικτύου για την υποστήριξη και επέκταση της μνήμης μας, η ανάπτυξη και η χρήση μιας ποικιλίας ευρετικών στρατηγικών για την αναζήτηση πληροφοριών στο Διαδίκτυο και η κρίση σχετικά με την αξιοπιστία των πληροφοριών, μεταξύ άλλων.