

# Emerging Technological Trends and Human Cognition: A Review

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## ABSTRACT

Emerging technology, around which our world now revolves, has changed the way we live, work, communicate and entertain. Online transactions, seeking information, learning new skills and even finding love are just a click away. However, the pertinent question remains: Has technology changed the world for the better? Our generation has witnessed the most drastic jumps in technological advances which have not only changed the way we perceive the world, but also how our brains receive and process information. It has led to much attention on the longer term implications of the use of technology, and therefore its impacts on human brains and their socio-emotional, cognitive and physical development. Various emerging technological trends like Artificial Intelligence (AI), Internet of Things (IoT), quantum computing, upgraded wireless technologies, automation, assistance tools etc. are also serving as tools for the promotion of cognitive abilities such as memory, learning, perception, problem solving, concept formation, and information processing. Cognitive development of children growing up in this era of digital technology has been influenced by exposure of Internet-based devices such as computers, tablets and smartphones in educational settings. It has been proved that the use of technology increases the multitasking ability, enhances learning and cognitive processing, develops intellect, and improves verbal or visuo-perceptual performance, wellness and quick decision making skills. But on the other hand, it also increases narcissism, diminishes cognitive capacity and intelligence, impairs memory and concentration, results in delay in the development of effective strategies for organizing and remembering information. This review article summarizes the possible impact of various technological exposures on socio-emotional development, physical development and human cognition such as memory, learning, problem solving, thinking, reasoning, retaining and recalling.

**Keywords:** Human cognition, Digital technology, Information, Learning, Multitasking

## INTRODUCTION

Digital technology refers to anything that is computerized. Almost every aspect of our lives are controlled by computers and smart devices. The music we listen to or videos which we watch right now is saved in digital technology formats, whether it's been downloaded or is streaming on different music or video platforms like Wynk, Spotify, Pandora or YouTube, Amazon, Netflix respectively. But with everything around us being so smart, it raises the question: are we still smart? This is a question that keeps coming up the more and more we rely on technology for everything.

The question is debated even more once we consider the cognitive development of youngsters that are developing with emerging technologies getting used

everywhere they turn. Technology has vital role to play in influencing the human cognition.

Technology may be defined as the application of scientific knowledge to the practical aims of human life or to the change and manipulation of the human environment. Whereas, the states and processes involved in knowing, which in their completeness include perception and judgment is called Cognition.

Cognition includes all conscious and unconscious processes by which knowledge is acquired. Human brain performs various cognitive activities such as learning, memory, perception, problem solving, concept formation etc. Technological trends be it artificial intelligence, Internet of things, quantum computing, aerospace technologies, or evolution in healthcare and

driving technologies have impact on human cognition. Let's discuss these technologies and their impacts on various cognitive capabilities:

**Artificial Intelligence (AI):** Driven by the emergence of device ecosystem including Alexa, Siri, and Google Assistant, AI has now become a part of everyday life. Motion recognition, computer vision and AI will have a breakout moment in manufacturing in the years to come. However, with AI taking the center stage, people are becoming dependent more on artificial intelligence and less on using own cognition which is somehow also resulting into learning difficulties, spelling mistake, reading and writing problems.

**Internet of Things (IoT):** Increased demand for edge computing processing power to fulfill the need to infer more data and then make decisions without sending data to the cloud is being fulfilled by practical deployment of IoT. Also, high-performing AI chips, known as neuromorphic or brain chips have the capability to mimic the structure of the brain and process top AI algorithms.

**Quantum Computing:** It is being commercialized rapidly for usage in mass scale to target the biggest problems in industry, such as health care and energy like cancer treatment, nuclear energy control, and DNA analysis.

**Upgraded Wireless Technologies:** Evolution of the Internet — deployment of 5G and Starlink broadband Internet technology are also likely to affect human cognition at great extent.

**Evolution of Healthcare:** Predictions at the genome level by using genomic analysis to learn about diseases and implement prevention and interventions.

**Evolution of Autonomous Driving Technology:** It has affected the procedural memory of human being as there is no need to remember the driving procedures as well as the mind body coordination.

**Technology and Human Cognition:** There are plenty of researches that show the benefits of technology on human cognitive functions. Research conducted by Wilmer, et al. (2017) reported that technology has a strong impact in terms of changing life, better leaping up the individual potentiality, learning enhancement, and

intellective development. It was also observed that *the digital exposure in early age increases the cognitive abilities of the children with enhanced cognitive processing* (Di Giacomo, et al., 2017). A study done at Princeton University has found that *expert video gamers have a higher ability to process data and to make decisions* in comparison to non-gamers.

Exposure of technology impacts the human cognitive functions by *enhancing the verbal or visuo-perceptual performance*. Technology changes life of the people by improving *the wellness in the social context and refining learning processing, enhancing cognitive performance* and so favouring high adaptability in the elaboration information processing.

A study using neuroimaging of frequent Internet users showed *twice as much activity in the prefrontal cortex* of the brain compared to sporadic users (Horvath, 2015). Quick decision-making as well as short-term memory are among the major known functions of this part of the brain. In a series of experiments by Fisher et al. (2015), adults who searched for answers to questions on the Internet reported an exaggerated sense of how well they could explain the answers to different, unrelated questions compared to adults who did not perform Internet searches. There could have a *positive effect on children's exploration and learning* using Internet-based devices by facilitating access to information that children cannot easily obtain on their own or from other people.

#### NEGATIVE EFFECTS OF TECHNOLOGY ON HUMAN COGNITION:

Efforts have been made to examine how smartphone technology can affect the brain and cognition during periods of heightened developmental plasticity. Hypothetically, frequent smartphone usage could be less harmful to adults, whereas children may experience more negative consequences as a result of their increased neural plasticity.

Researches suggest that usage of smartphones is not always on the equal plane. Various apps along with approaches to multitasking may moderate the relation between smartphone use and several cognitive skills. Some media headlines encourage public perception that smartphones have a definite and negative impact on

cognitive functioning without having any conclusive finding. In particular, social activities such as text messaging, email, and social media use have different impacts than gaming or browsing the web.

Professor Susan Greenfield expresses concern that *social networking will displace the 'true self' with an exaggerated, ideal self*. She also warns that digital technology demonstrably *increases narcissism* (Horvath, 2015).

Prolonged access to the Internet *diminishes cognitive capacity and intelligence* (Bauerlein, 2008; Carr, 2011; Greenfield, 2015). Ephron (2008) wondered if "Google will mean the end of conversation as we know it" as individuals spend more time searching answers from net and less time seeking them from other people indicates that Internet use *has impaired their memory and concentration* (Näsi, 2013).

Much of the popular concern about the effects of accessing vast amount of information online focuses on memory which was also called "Google effect" on memory, Sparrow, Liu, and Wegner (2011) demonstrated that *college students showed diminished memory for the unimportant information* which could be accessed on a computer. Dong & Potenza (2015) has stated that people who search for information on the Internet also remember less of the information than those who search in a printed encyclopedia, and show *diminished activation of brain areas* that are associated with the formation of long-term memories.

Many studies show that exposure to technology is modifying our cognitive processes as well our ability to grasp information. The findings reflect that the society is morphing into one of '*cognitive offloaders*'. We tend not to memorise important information and just remember the location where the relevant information can be retrieved.

Children might not feel forced to remember information which can be accessed via Internet or any device, *delaying the development of effective strategies for organizing and remembering information*. For instance, children no longer need to memorize their friends' phone numbers. As a result, they may have fewer opportunities to learn and organize strategies like rehearsal or clustering.

Amidst a society powered by technology, constant

engagement with our smartphones, tablets, laptops and other Internet-based technologies is becoming the norm. As per studies, exposure to devices of these kinds is affecting the way we think and, as a byproduct how we learn. Evidence show that using a hand-held device to take photographs or share experiences on social media *diminishes memory* for the experience (Tamir, et al., 2018).

#### BROADENING IMPACT OF TECHNOLOGY ON COGNITIVE CAPABILITIES:

**Shorter Attention Spans due to Distraction from Various Sources:** With all the distractions we have these days, it's very hard to stay focused on particular task. These technological distractions affect our interpersonal as well as intrapersonal relationships, productivity and ability to learn all of which require a certain level of concentration (Elgan, 2017). Submerged constantly and completely with information also impacts our creativity as well as our contemplative ability. Now it's believed that we can only concentrate for about 8 seconds on average before moving on to something else which was earlier 12 seconds (McSpadden, 2015).

**Improved in Multitasking Abilities:** Many of us brag about how we can do several things at once. We can talk on phone, watch Youtube videos and compose email replies as well at the same time. However, researches point to the fact that performing different activities that is based on the same type of brain processing isn't possible. Doing so only reduces brain efficiency and makes it harder for us to retain information (Galasso, 2016).

**Tech Addiction:** There's a certain gratification that comes with seeing new notifications and messages once the message tone pings which is why some of us compulsively check social media platforms numerous times each day, spending hours blissfully. Due to excessive use of video or mobile game and Internet, some people end up suffering, needing rehabilitation and professional help for detoxification (Carter, 2017). The reason behind this is the pleasure centers of the brain which are stimulated by the built-in gratification factors in technology, which makes us crave for more.

**Face-to-face Interactions have been Undermined:** You must have been out with friends sometimes and at some

point noticed all of you were spending more time staring at your screens than chatting with each other? It's even worse for kids and teens who have grown up in the digital era since many haven't developed conversation skills or learned to read social cues (Sundance Canyon Academy, 2015). As a result, natural communication has taken a backseat.

People are Becoming More Forgetful: Research has revealed that many millennials are more forgetful than seniors something that can be attributed to the constant use of technology. In order to remember something, we need to move that information from our working memory (conscious mind) to our long-term memory and this hinges on our attentiveness (Emling, 2013). While, we are constantly in the mode of soaking in new information, thanks to technology, we are not giving enough time to think or process the information and commit it to memory. This, in a way, is making us more forgetful.

## DISCUSSION

Due to the pervasiveness of technology, a concerted effort must be made to guard children and adolescents from the risks related to technology use, and also to push positive habits and modes of use that are beneficial for cognitive development. Clearly, technology also provides children with variety of learning and socialisation opportunities, and digital competence will likely be necessary for the coming generations. Screen time guidelines from many countries, with an outsized specialize in setting limits on exposure, can be too simplistic and fail to account for a few of the nuances related to how children and adolescents use technology like what they use it for, once they are using it, and also the differing kinds of screens they engage with throughout the day.

There are divergent views of researchers (e.g., Bauerlein, 2008; Carr, 2011; Greenfield, 2015) that the prolonged access to the internet diminishes cognitive capacity and intelligence. Similar finding was also reported by Näsi (2013) that internet use has impaired person's memory and concentration.

However, Di Giacomo et al. (2017) observed that the digital exposure in early age increases the cognitive

abilities of the children with enhanced cognitive processing. Some of other research findings also suggests that the exposure of technology impacts the cognitive functionality by enhancing the verbal or visuo-perceptual performance. Technology changes life of the people by improving the wellness in the social context and refining learning processing, enhancing cognitive performance and so favouring high adaptability in the elaboration information processing.

Horvath (2015) reports that our immediate environment plays a big role in shaping our brains and it's the 'thinking' vis-à-vis our environmental experiences that is guiding our brains. Despite widely publicized recommendations (AAP Council on Communications and Media, 2016a,b), people know very little about the most appropriate age for a child to begin using a smartphone, and know equally little about the consequences of using one too early in life (Wilmer, et al., 2017).

Several studies have been carried out in the area of internet gaming. A study (Lemmens, 2015) found that enjoying video games might facilitate, improve visual modality by teaching the brain to identify little details, follow movements and spot refined lightweight changes, a minimum for individuals with visual difficulties. Another study suggested that video games facilitate kids with learning disability by allowing them to browse quicker and with higher accuracy (Gentile, et al., 2011).

Another study emphasized increase in gray matter within the right hippocampus, the proper anterior cortex which measure crucial for spatial navigation, strategic designing, remembering and motor performance. The raised gray matter in these components of the brain is correlative with higher memory and small gray matter is correlative with major affective disorder (Forward, 2019).

The study suggests that computer game coaching might be accustomed to best-known risk factors for smaller hippocampus and anterior cortex volume in, for instance, post-traumatic stress disorder and psychosis (Scott-Jones, 2017). Carter (2017) showed that video game use isn't related to a raised risk of mental state

issues but to higher intellectual functioning. Scott-Jones suggests that enjoying some video games could even overcome the psychological feature skills littered with economic condition like focus, self-control, and memory. Apart from the benefits, most of the harmful effects of video games measure curst on the violence they contain. Children playing a lot of violent video games possess raised aggressive thoughts, feelings, and behaviors, and small pro-social serving. King, et al. (2011) suggests that chronic exposure to violent video games isn't solely related to lower sympathy, however, emotional feeling lessens.

Similarly, researchers argue for a “consistent correlation” between violent game use and aggression, however find lean proof to link violence with video games and have noted that there's a small rate of juvenile crime that coincides with the recognition of games like Death Race, Mortal Kombat, Doom and Grand larceny automobile. It was concluded that video game is habit-forming for teenagers, and found that the impulsive part of the brain, referred to as the amygdala-striatal system was a lot of sensitive in line with significant game players between thirteen and fifteen whose self-control system isn't however well-developed will have raised susceptibleness to different sorts of addiction and may be a lot of susceptible to impulsive and risky behaviors later in life (Van et al., 2014).

A meta analysis of twenty four studies concluded that violent video games had very little impact on kids' aggression, mood, serving to behavior or grades but suggested that players may follow riskier behaviors like reckless driving, binge drinking, smoking and unsafe sex (Scharkow et al., 2014). Marks (2014) found that teenaged players readily leave the emotional effects of the sport behind, once the sport is over. These players navigate through the sport tract mistreatment in-system navigation tools or on-screen GPS, looking forward to steering “habit” rather than active learning and which causes a rise within the quantity of grey matter in their basal ganglion, whereas it decreases within the hippocampus (Brand, Laier, & Young, 2014). Reduced grey matter within the hippocampus has antecedently been joined to higher risks of brain diseases, together with depression, psychosis, PTSD, and Alzheimer's disease. But, games that need players to navigate spatial

methods like the 3D Super Mario games have increased nervous tissue within the hippocampus.

Though, many computer games make the child socially isolated, among gamers, being a individualist is not the norm. Some video games teach children the incorrect values. King et al. (2011) have shown that the longer a child spends enjoying video games, the poorer is his performance in class. Winkler et al. (2013) found that computer game addicts argue plenty with their academics, fight plenty with their friends, and score lower grades than others and a lot of game players habitually skip their studies to play games. Video games may have dangerous effects on some children's health, together with blubber, video-induced seizures, muscular and skeletal disorders, like inflammation, neurological disease and carpal tunnel syndrome. When enjoying on-line, child may develop dangerous language and behavior from others, and make child prone to on-line dangers. Kids' defrayment an excessive amount of time enjoying video games could exhibit impulsive behavior and have attention issues (King et al. 2012).

On contrary, studies have shown that enjoying video games enhances a child's concentration and facilitate children's attention problems, raising the flexibility to concentrate in brief bursts however damaging semi-permanent concentration (Young, 2011).

Nowadays video games have been a large and growing part of our culture as well as an emerging market. It has many characteristics of other addiction disorders including deleterious physical and mental health consequences. The social and omnipresent nature of gaming makes it a bit difficult to identify the signs and symptoms of excess gaming. There has been too little serious public policy debate concerning the best measures to reduce the exposure of media violence on children and youth. It is right time to move on to the more difficult public policy questions concerning whether modern societies should take action to reduce the high rates of exposure of children and youth to media violence, and if so, what public policies would likely be the most effective (Singh et al., 2020).

## CONCLUSION

The continuous bombardment of information, be it

visual, text, graphics or videos or any other digital stimuli, is captivating our brain, and making it accustomed to scan information and choose what appears important while disregarding the rest. The brain is narrowing in on snippets of detail, which is making many researchers fear that our brains are losing their facility for prolonged concentration. When Internet-based devices such as computers, tablets, and smartphones used to aid learning, technology can be a significant educational tool. However, it's important to be abreast about the facts about how technology, however insignificant it might seem, is used in and out of the domain of the classrooms. Although, parents play an important role in mediating children's access to technology, it is important to keep in mind that children's understanding of Internet-based devices develops in conjunction with other cognitive skills. However, it's hard to say how technology is going to affect our brains in the long-term. While majority of the researches worldwide are still in the preliminary domain, one thing that those have pointed towards is the capability of the human brain its plasticity and malleability. With technology continually evolving, it's good news that are brains are able to keep up. The brain can be trained to rewire itself. "It is this neuroplasticity that allows for rehabilitation which can be achieved with environment stimuli like exercise" (Professor Tony Hannan, neurobiologist, the Florey Institute). After studying various findings, it could be clearly concluded that the exposure of technology has positive as well as negative impacts. If we look at the benefits, it increases the ability to multitask, enhances learning and cognitive processing, develops intellect, and improves verbal or visuo-perceptual performance, wellness and quick decision making skills. On the other hand it increases narcissism, diminishes cognitive capacity & intelligence, impair memory and concentration, results in delay in development of effective strategies for organizing and remembering information.

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