Consequences of Brain Health in the Digital Era

Manish Kumar, Vaibhav Shamrao Ingale, Amandeep Kaur, and Kashish Bhatia

Abstract Recent scientific evidence suggests that frequent use of digital technology, such as problematic mobile use (PMU), has both negative and positive effects on brain function and behavior. Excessive screen time and technology use can lead to attention deficit symptoms, impairments in emotional and social intelligence, technology addiction, social isolation, impaired brain development, and sleep disturbances. Moreover, the COVID-19 pandemic has further increased screen time for both adults and children due to virtual classrooms. This has harmed brain health, as individuals have been attending their classes and working online without interaction with peers. However, certain online games and apps can improve neural activity in the brain. Additionally, numerous apps and digital tools are available to manage mental health issues, such as self-management, monitoring, skill training, and enhancing mood and behavior. In this digital era, we are akin to sailors without rudders, being driven by digital stimuli rather than our deliberate direction in the ocean. This chapter explores the various consequences for brain health in this digital era.

Keywords Brain health · Emotional and social intelligence · Skill training · Digital apps

1 Introduction

In the past, our great-grandparents were not exposed to the digital life that exists today. They relied solely on interpersonal communication and a few other sources for their information. However, in contemporary times, people of all ages are consuming and processing vast amounts of data from the digital world. Moreover, they are not just consuming data, but also generating large quantities of it in their daily

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lives. The number of internet users worldwide (in millions) from 2006 to 2020 is displayed in Fig. 1 (Source: FinancesOnline).

Over the past 3 years, people, especially the younger generation, have become more at ease with the digital world than the physical one. They spend the majority of their time online, and this shift toward an online existence has created a new field of study for neuroscientists [1]. They can now investigate how digital technology is changing the functioning of our brains and our behavior. However, as with most things, there are both positive and negative impacts. Neuroscientific data indicates that the digital era is affecting the brain in both negative and positive ways. For example, an elderly individual who can maintain their independence by using various digital apps is a positive outcome. Scientists use Magnetic Resonance Imaging (MRI) to track brain health and neural activity to measure the effect of the digital era on the brain. This chapter will cover all of the impacts that the digital era has had on the human brain.

The COVID-19 pandemic has had various impacts on children, particularly on their personality and brain health. Schools are supposed to shape children's personalities and brains with a positive approach, but unfortunately, the system often restricts them to a rat race, leading to anxiety, depression, and other mental illnesses at an early stage. With the pandemic, children have become more reliant on the internet for education and leisure activities. Additionally, the neglect of mental health issues has further exacerbated these problems. To understand how twenty-first century children have been affected, four main themes need to be taken into consideration as shown in Fig. 2 [2].

The digital era has brought about numerous benefits to society, but it has also resulted in potentially harmful effects on brain health. Some of the harmful effects have been discussed in further sections.

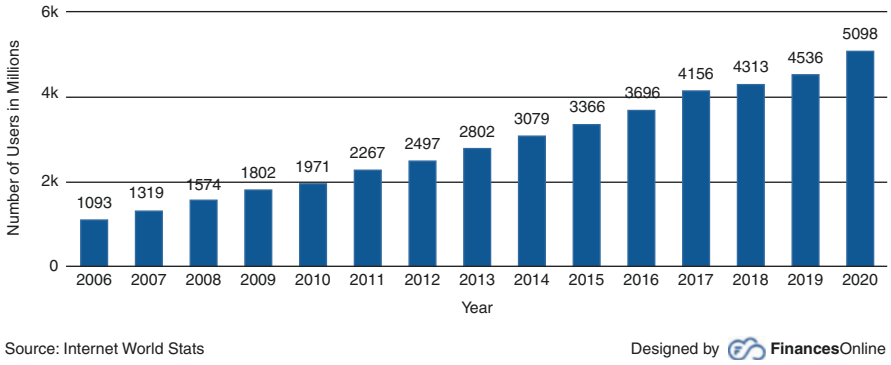

Fig. 1 Number of internet users worldwide (in millions) from 2006 to 2020

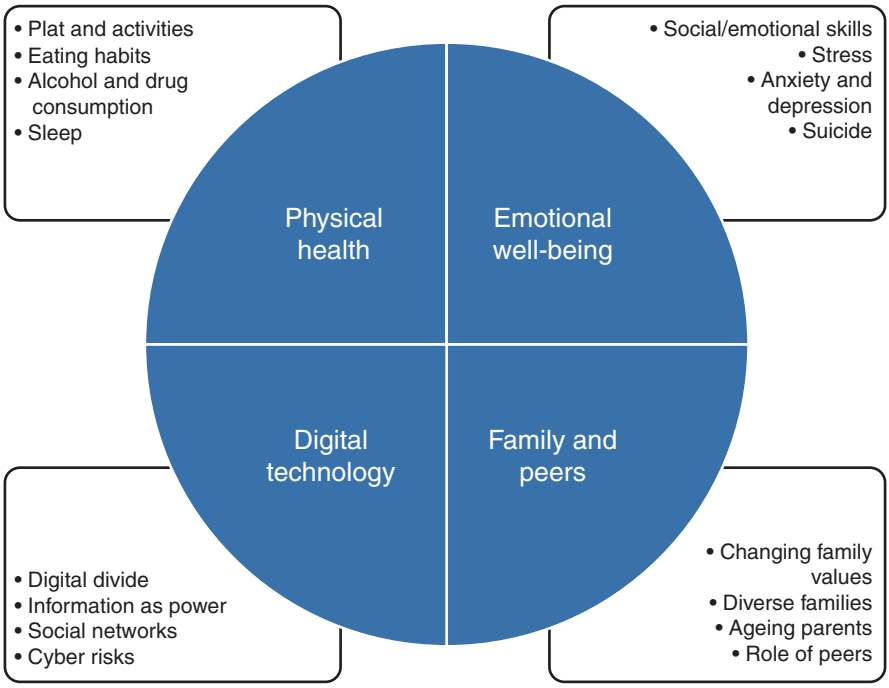

Fig. 2 Four main themes for analysis of twenty-first century children issues [2]

1.1 Attention Deficit Disorders

Many studies have shown a link between screen time on computers, mobile, or tablets and symptoms of Attention Deficit Hyperactivity Disorder (ADHD). Scientists have found a close association between excessive usage of digital media and symptoms of ADHD. Also, when people are online often they get less time to interact offline and reset their brains [3]. ADHD is a neurodevelopmental disorder that affects both children and adults. It is characterized by symptoms of inattention, hyperactivity, and impulsivity. People with ADHD may struggle with staying focused, paying attention, completing tasks, organizing themselves, and controlling their impulses.

The exact cause of ADHD is not fully understood, but it is believed to be a combination of genetic and environmental factors. Some of the common risk factors for ADHD include genetics, brain structure, and function, exposure to toxins, premature birth or low birth weight, and maternal smoking during pregnancy.

ADHD can be diagnosed by a healthcare professional based on the symptoms, medical history, and behavioral assessments. Treatment for ADHD may include medication, behavioral therapy, and lifestyle modifications. Medications such as stimulants and non-stimulants can help improve attention and reduce hyperactivity

and impulsivity. Behavioral therapy can help individuals with ADHD develop coping strategies and improve their social skills, organization, and time management.

It is important to note that ADHD can impact people in different ways and that each individual's experience with the disorder is unique. With the right treatment and support, individuals with ADHD can learn to manage their symptoms and lead fulfilling lives.

1.2 Impairments in Emotional and Social Intelligence

The amount of time children spend online has significantly increased as everything becomes digital, but it is recommended by the American Academy of Pediatrics that screen time for children aged 2 years or younger should be limited due to the brain's heightened malleability at that age.

Spending excessive time online can reduce opportunities for face-to-face communication, and Kirsh and Mounts [4] hypothesized that playing video games can interfere with the ability to recognize human emotions. They studied the effects of playing video games on the recognition of facial expressions of emotions in 197 students and discovered that participants who had played violent video games before viewing a calm face were unable to recognize the emotion. Some of the bad effects of technology are displayed in Fig. 3.

Problematic mobile use (PMU) refers to a pattern of excessive and compulsive use of mobile devices, such as smartphones and tablets, that leads to negative consequences for the user. PMU is sometimes also referred to as mobile phone addiction, smartphone addiction, or nomophobia (fear of being without a mobile phone).

PMU is characterized by a range of symptoms, including the following:

- Spending an excessive amount of time on mobile devices, often at the expense of other important activities such as work, school, or socializing with others.
- Feeling a compulsive need to check one's mobile device regularly, even when it is not necessary or appropriate.
- Experiencing anxiety or distress when separated from one's mobile device or unable to use it for some time.
- Neglecting personal hygiene or self-care in favor of using a mobile device.
- Experiencing negative consequences as a result of PMU, such as poor academic or work performance, social isolation, relationship problems, or physical health issues.

PMU is a growing concern in today's society, as mobile devices have become an integral part of many people's daily lives. While the majority of mobile device users do not experience PMU, for those who do, it can have a significant impact on their well-being and quality of life. Treatments for PMU typically involve cognitive-behavioral therapy, which focuses on changing problematic behaviors and thought patterns related to mobile device use.

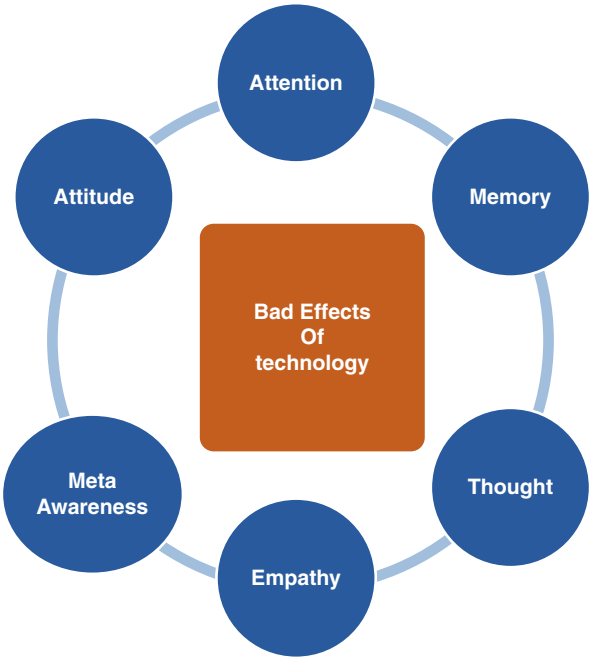

Fig. 3 Bad effects of technology in different ways

1.3 Physical Effects

Physical effects are the most easily quantifiable of other negative effects of technologies on the brain. Metabolic disease can be a very common cause of the use of technologies in daily life. As we sit with a digital device, it indirectly reduces the movement of the body. Movement of the body is required to stay healthy. Therefore, screen time and digital usage not only affect the brain but the entire body.

Prolonged and excessive use of screens can cause several health problems, including eye strain, headaches, neck and shoulder pain, back pain, and sleep disturbances. Here are some more diseases and conditions that can be associated with severe screen use:

- Computer vision syndrome (CVS): This condition includes a range of vision-related problems, such as eye strain, dry eyes, blurred vision, double vision, and headaches. CVS is often caused by the prolonged use of digital devices, especially computers.
- Carpal tunnel syndrome: This is a condition that causes numbness, tingling, and weakness in the hand and wrist. It is caused by pressure on the median nerve, which runs through the wrist. Repetitive use of a keyboard or mouse can increase the risk of developing carpal tunnel syndrome.

- Tennis elbow: Also known as lateral epicondylitis, tennis elbow is a condition that causes pain and inflammation in the elbow. It is often caused by repetitive use of the forearm muscles and tendons, such as when using a computer mouse or typing on a keyboard.
- Text neck: This is a term used to describe the neck pain and stiffness caused by constantly looking down at a phone or other digital device. The posture associated with this behavior can strain the neck muscles and lead to long-term neck problems.
- Insomnia: Exposure to blue light from digital devices can interfere with the body's natural sleep cycle and make it more difficult to fall asleep. This can lead to insomnia and other sleep disorders.
- Obesity: Spending too much time in front of screens can lead to a sedentary lifestyle, which is a major risk factor for obesity and other health problems.
- Anxiety and depression: Studies have shown that excessive screen use, particularly social media, can contribute to anxiety and depression in both children and adults.

It's important to take breaks from screen use, practice good posture, and maintain a healthy lifestyle to prevent these and other health problems associated with excessive screen use.

1.3.1 Mental Health

One of the major problems associated with the digital era is addiction, which can have detrimental effects on mental health, social life, and family bonds. Additionally, chronic smartphone stress has been identified as a newly discovered effect on health. Children who overuse technology are at a higher risk of developing serious mental health issues, including reduced attention and thinking power, delayed language, social and emotional development, and addiction to technology. Teenagers aged 15 to 16 years have been found to use digital media for longer periods, increasing the likelihood of creating symptoms of attention deficit hyperactivity disorder (ADHD). Furthermore, there are several other mental health issues associated with the digital era as mentioned below and as detailed in [5].

- Addiction.
- Anxiety and depression.
- Attention deficit hyperactivity disorder (ADHD).
- Decreased attention span.
- Poor sleep quality and insomnia.
- Impaired cognitive function.
- Decreased social skills and increased social isolation.
- Cyberbullying and online harassment.
- Low self-esteem.
- Body image issues.
- FOMO (fear of missing out).

- Online gaming addiction.

It's important to note that these issues may not affect every individual who uses digital media excessively, and the severity and prevalence of these issues can vary from person to person. However, it's still important to be aware of these potential risks and to use digital media in moderation to promote overall well-being.

1.3.2 Social Health

Social health is affected to a great extent due to the dependency on digital devices. A connection with the community is lost. For instance, earlier people used to visit banks physically and were patient enough to wait in queues to get their work done and there was a usual social connection. But with the advent of Internet banking facilities, the banks are now at a single click of our finger and the interaction with the community is lost [6]. Following are some of the one-liners which deprecate the effects of the digital era on human health.

- "Digital technologies have made it more difficult for me to say on task and devote sustained attention. This interferes with my work productivity."
- "I can't seem to get my brain to calm down and focus. It is all over the place. I can't concentrate. I just start thinking about what I'm going to do next."
- "Increased isolation is a negative effect I feel in my life; the time I spend using digital technologies could well be spent in other more creative and productive ways."
- "I am becoming increasingly aware of the way constant access to digital forms of communication can be overwhelming."
- "It has become an ever-present overhang on all aspects of life. There is no escape."
- "The rise of hatred, the manipulation of politics, and so on – these are not distant events with no personal impact."
- "Digital life has tipped the balance in favor of John Stuart Mill's 'lower pleasures' and has made engaging in higher-order pleasures more difficult."
- "One major impact is the overall decrease in short-term memory, and … what was the question?"
- "Real-life relationships are less bearable; everyone is so much less interested with the spoiling of technology."
- "Digital technology radically increases expectations for instantaneous responses. This is unhealthy."
- "It has become harder to take your eyes off a screen to enjoy life as it's happening."
- "Technology is being driven by business across all areas for money, money, money. Greed has taken over."

1.3.3 Impact on Cognitive and Brain Development

The use of screens has the potential to negatively affect cognitive and brain health, as shown in research [7]. Previous studies have revealed that children under the age of two spent approximately 1 h per day on screens, but this number increased to 3 h per day by the age of three. For infants aged between 6 and 12 months, excessive screen time has been linked to poorer early language development and behavioral problems.

Although digital media can aid in active learning in preschool and older children, it should be accompanied by parent–child interaction. However, excessive screen time and a lack of reading time have been linked to decreased brain connectivity in the areas of the brain responsible for word recognition, language, and cognitive control in children aged eight to twelve. This reduced connectivity can negatively impact reading skills, which highlights the detrimental impact of screen time on brain development. Given the increasing prevalence of screen use among very young children, whose brains are highly plastic, there is growing concern about the cognitive and brain development of children exposed to screens, which warrants further study.

1.3.4 Sleeping Patterns

Recent research suggests that screen time can negatively affect sleep, which in turn can impact cognition and behavior. Studies have shown that daily touch-screen use is associated with sleep disturbances such as reduced duration and increased night-time awakenings in infants and toddlers. Spending more time on mobile phones and touch screens is linked to more sleep disruptions, while tablet use is associated with poor sleep quality and more awakenings after sleep onset. Poor sleep quality can lead to brain changes, including decreased functional connectivity and gray matter volume, and increase the risk of age-related cognitive impairment and Alzheimer's disease.

Although it is unclear whether looking at screens or watching media content disrupts sleep, it is well established that the wavelength of light exposure affects circadian rhythms, and light-emitting diode (LED) screens on computers and phones emit slow-wave blue light that can disrupt these rhythms. Exposure to LED screens has been shown to alter melatonin levels and sleeping quality and reduce cognitive performance. Therefore, it is crucial to recognize the effects of screen time on sleep as a moderator of multiple negative impacts on memory and brain function.

1.3.5 Effects on Brain Functions

In a study, functional MRI was used to record neural activity in the brains of 12 participants who had never used the internet before and 12 who had, while performing simulated internet search tasks. It was hypothesized that the net-naive group would show increased activation in their frontal lobe network after internet training, whereas the net-savvy group would either show no change or a reduction in activation due to increased cognitive efficiency after training. During their initial scan, the net-naive group recruited a neural network that included various regions of the brain, and only this group showed additional activation in the middle and inferior frontal gyri during their second scan as shown in Fig. 4.

The net-savvy group initially displayed more extensive activation in a cortical system that controls mental activities involved in internet search tasks, but they showed a trend of reduced activation following the training, which is consistent with the hypothesis that the brain becomes more efficient and habituates to the task over time. These findings suggest that even short periods of internet browsing can alter brain activity patterns in middle-aged and older adults.

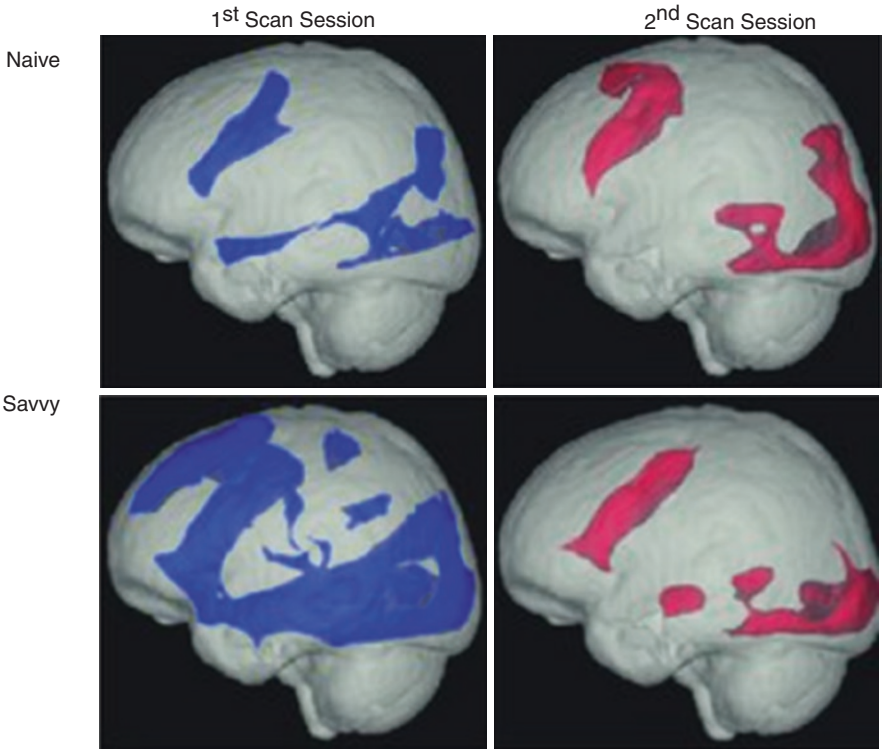

Fig. 4 Comparison between internet searching tasks before and after training

Several other research teams have studied how internet search training affects brain function and structure. One study [8] utilized diffusion tensor imaging to explore the impact of brief internet search training on the microstructure of white matter. They found that after just 6 days of training, the 59 participants (average age of 21) had an increased fractional anisotropy in the right superior longitudinal fasciculus and a reduced radial diffusivity in that area. These results imply that short-term internet search training can improve the integrity of white matter in the right superior longitudinal fasciculus, perhaps due to increased myelination.

2 Technological Interventions to Monitor and Protect from the Harmful Effects on Brain Health in a Digital Era

Several technological interventions can be used to monitor and protect individuals from the harmful effects of excessive screen time:

- Screen time tracking apps: These apps help individuals track and monitor their screen time and set usage limits. Some examples of screen time tracking apps include Moment, Screen Time, and Freedom.
- Blue light filters: These filters can be applied to digital devices, such as smartphones and tablets, to reduce the amount of blue light emitted. Blue light has been shown to disrupt circadian rhythms and negatively affect sleep. Some devices have built-in blue light filters, or users can download software that adds the filter.
- Parental controls: These features allow parents to set limits on their children's screen time and restrict access to certain apps and websites. Many devices have built-in parental controls, and there are also third-party apps available.
- Digital detox programs: These programs are designed to help individuals take a break from digital devices and reduce their screen time. Some examples of digital detox programs include the 30-Day Digital Detox Challenge and the National Day of Unplugging.
- Mindfulness and meditation apps: These apps help individuals practice mindfulness and meditation, which have been shown to reduce stress and improve mental well-being. Some examples of mindfulness and meditation apps include Headspace, Calm, and Insight Timer.

These technological interventions can be effective in helping individuals monitor and protect themselves from the harmful effects of excessive screen time. However, it's important to remember that reducing screen time and practicing other healthy habits, such as exercising and socializing in person, are also important for maintaining good brain health in the digital era. Some more techniques involving brain training have been discussed in this section.

2.1 Method of Cognitive Training to Improve Brain Health

Cognitive training refers to a set of activities or exercises designed to improve cognitive functions such as attention, memory, and problem-solving. Cognitive training has been studied as a potential intervention to improve brain health and cognitive abilities in older adults and individuals with neurological disorders.

Several methods of cognitive training have been developed to improve brain health, and some of them are discussed below:

- Computerized cognitive training: This method involves the use of computer-based programs designed to improve cognitive functions. These programs typically involve a series of exercises that challenge various cognitive skills, such as working memory, attention, and processing speed. The exercises can be adjusted in difficulty and intensity to suit individual needs.
- Cognitive stimulation therapy: This method involves engaging individuals in group activities that stimulate cognitive functions, such as discussion, reminiscence, and problem-solving. The activities are designed to be enjoyable and engaging to encourage participation.
- Mindfulness training: This method involves the practice of mindfulness meditation, which is aimed at improving attention and emotional regulation. Mindfulness training typically involves focused breathing and attention to the present moment.
- Physical exercise: Physical exercise has been shown to improve cognitive functions, particularly executive functions such as planning, decision-making, and working memory. Exercise may improve brain health through increased blood flow and neuroplasticity.
- Cognitive-behavioral therapy: This method is a type of psychotherapy that focuses on changing negative thinking patterns and behaviors that may be contributing to cognitive problems. Cognitive-behavioral therapy may involve problem-solving exercises, cognitive restructuring, and behavioral activation.

Overall, the goal of cognitive training is to improve cognitive function and promote brain health. The specific method of cognitive training used may depend on individual needs, preferences, and cognitive strengths and weaknesses. Cognitive training involves exercising the brain rigorously using intense mental exercises. Many applications can keep your brain busy as listed in Table 1.

Many other applications can help to keep the brain active and healthy while using digital devices. However, it is suggested to try and adopt natural cognitive training methods by taking a leave from the digital world for a short while. Following are some of the benefits of cognitive training which encourage taking care of the brain.

Table 1 Mobile apps to keep the brain active [9]

N	Name of the app	Features
1.	Lumosity	Improvement in memory and focus, concentration, mindfulness, cognitive ability
2.	Duolingo	Lessons in over 35 languages, language learning, and practicing tools
3.	Calm	Reduces anxiety, meditation, music, sleep stories, self-care
4.	Psychology compass	Cognition coach, weekly lessons to automate habits
5.	Headspace	Sleep-aiding tools, guided meditations, music
6.	Ten percent happier	Topic-specific meditations
7.	Insight timer	Workshops, guided meditations, music, etc.
8.	TED	Inspire me feature, many languages supported, world-class thinkers
9.	Forest	Virtual forests creation to view habitual changes, reminders, targets, and routines
10.	Words with friends	Build vocabulary, words with friends feature, challenges, games
11.	Chess—play and learn	Puzzles, brain games

2.2 Cognitive Behavioral Therapy

Cognitive-behavioral therapy (CBT) is a type of psychotherapy that aims to help individuals improve their mental health by changing negative thought patterns and behaviors. It is a goal-oriented, problem-solving approach that is based on the idea that thoughts, feelings, and behaviors are interconnected.

CBT is effective in treating a wide range of mental health conditions, including anxiety disorders, depression, post-traumatic stress disorder (PTSD), obsessive-compulsive disorder (OCD), and eating disorders. It is also used as a complementary therapy for individuals with chronic pain, sleep disorders, and substance abuse.

The basic principles of CBT include the following:

- Cognitive restructuring: This involves identifying and challenging negative thought patterns that may be contributing to mental health problems. The therapist helps the individual to replace negative thoughts with more positive, realistic ones.
- Behavioral activation: This involves identifying and changing negative behaviors that may be contributing to mental health problems. The therapist helps the individual to develop new, positive behaviors that promote mental health.
- Exposure therapy: This involves gradually exposing individuals to situations that trigger anxiety or fear, to reduce their sensitivity to these triggers.
- Relaxation techniques: This involves teaching individuals relaxation techniques such as deep breathing, progressive muscle relaxation, and visualization to help reduce anxiety and stress.
- Homework assignments: Individuals are often given homework assignments to practice the skills learned in therapy, such as challenging negative thoughts or practicing relaxation techniques.

CBT is typically a short-term therapy, lasting between 12 and 20 sessions. However, the length of therapy may vary depending on the individual and the severity of their mental health condition. CBT can be delivered in various formats, including individual therapy, group therapy, and online therapy. The therapy can also be adapted for children and adolescents. Overall, CBT is a structured, evidence-based therapy that can help individuals improve their mental health by changing negative thought patterns and behaviors. It is a highly effective treatment option for a range of mental health conditions and can be tailored to individual needs and preferences.

2.3 Meditation Apps

Meditation apps have become increasingly popular in the digital era as a way to improve brain health. These apps offer a convenient and accessible way to practice mindfulness meditation, which has been shown to have numerous benefits for mental and physical health. Meditation apps typically offer guided meditations, which can be tailored to different levels of experience and different goals. For example, some apps offer meditations for stress reduction, while others offer meditations for sleep or anxiety.

There are several benefits of using meditation apps for brain health, including the following:

- Stress reduction: Mindfulness meditation has been shown to reduce stress and anxiety, which can have a positive impact on brain health. Studies have found that regular meditation practice can reduce the size of the amygdala, which is part of the brain that is responsible for the Fight-or-flight response.
- Improved cognitive functions: Regular mindfulness meditation practice has been shown to improve cognitive functions such as attention, memory, and executive function. Studies have found that meditation can increase gray matter volume in the prefrontal cortex, which is part of the brain that is responsible for decision-making and planning.
- Improved emotional regulation: Mindfulness meditation can improve emotional regulation by helping individuals become more aware of their thoughts and emotions. Studies have found that regular meditation practice can reduce symptoms of depression and anxiety.
- Better sleep: Mindfulness meditation can improve sleep quality by reducing stress and promoting relaxation. Studies have found that meditation can improve sleep duration and reduce the time it takes to fall asleep.

Some popular meditation apps include Headspace, Calm, and Insight Timer. These apps offer guided meditations of varying lengths and can be accessed on a smartphone or tablet. Some apps also offer features such as progress tracking and personalized recommendations. Overall, meditation apps can be a useful tool for improving brain health in the digital era. However, it is important to remember that

meditation is a practice that requires regular and consistent effort. Like any form of exercise, the benefits of meditation come with regular practice over time.

2.4 Wearable Technology

Wearable technologies have become increasingly popular in the digital era as a way to improve brain health. These technologies include devices such as fitness trackers and smartwatches, which can track physical activity, sleep patterns, and heart rate, among other metrics. These data can provide valuable insights into the overall health and can be used to inform lifestyle changes that can have a positive impact on brain health.

Some of the ways in which wearable technologies can improve brain health are as follows:

- Encouraging physical activity: Regular physical activity has been shown to have numerous benefits for brain health. Wearable fitness trackers can help individuals monitor their activity levels and provide feedback on progress toward activity goals.
- Improving sleep: Sleep is critical for brain health, and poor sleep has been linked to a range of cognitive and emotional problems. Wearable technologies that track sleep patterns can provide individuals with valuable information about their sleep quality, which can be used to make lifestyle changes that improve sleep.
- Reducing stress: Wearable devices such as smartwatches can provide feedback on stress levels and offer features such as guided breathing exercises to help individuals manage stress.
- Monitoring heart health: Heart health is closely linked to brain health, and wearable devices can track metrics such as heart rate variability, which is an indicator of overall cardiovascular health. Improving heart health can have a positive impact on brain health by improving blood flow to the brain.
- Providing feedback on cognitive performance: Some wearable technologies offer cognitive performance tracking, which can provide individuals with feedback on cognitive functions such as attention, memory, and executive function. This feedback can be used to inform lifestyle changes that improve cognitive performance.

Wearable technologies have the potential to be a valuable tool for improving brain health in the digital era. However, it is important to use these technologies in conjunction with other lifestyle changes such as regular physical exercise, healthy diet, and social connection. Additionally, it is important to use these technologies in moderation and to seek professional advice before making significant changes to lifestyle or starting any new exercise or health program.

2.5 Virtual Reality Technology

Virtual reality (VR) technology has emerged as a promising tool for improving brain health in the digital era. VR technology creates a simulated environment that can be experienced through a VR headset, allowing users to engage in activities and experiences that can have a positive impact on brain health.

Some of the ways in which VR technology can improve brain health are as follows:

- Stress reduction: VR technology can create immersive environments that can help users relax and reduce stress. For example, VR-guided meditations can create a calming environment that can promote relaxation and reduce stress levels.
- Cognitive training: VR technology can be used to create cognitive training programs that can help improve cognitive functions such as attention, memory, and executive function. VR cognitive training programs can provide a more engaging and immersive experience than traditional cognitive training methods, which can increase motivation and adherence to the program.
- Rehabilitation: VR technology can be used in rehabilitation settings to help individuals recover from brain injuries and improve motor function. For example, VR games can be used to improve hand-eye coordination and balance.
- Exposure therapy: VR technology can be used to create simulated environments that can help individuals overcome fears and phobias through exposure therapy. For example, VR exposure therapy can be used to help individuals overcome their fear of heights or fear of flying.
- Social connection: VR technology can be used to create virtual social environments that can help combat loneliness and social isolation, which are risk factors for cognitive decline and dementia.

While VR technology has the potential to improve brain health in numerous ways, it is important to use this technology in moderation and under the guidance of a trained professional. Additionally, VR technology is not suitable for everyone and may not be appropriate for individuals with certain medical conditions. As with any new technology or treatment approach, it is important to consult with a healthcare professional before incorporating VR technology into a brain health program.

2.6 Brain Stimulation Devices

Brain stimulation devices have become increasingly popular as a way to improve brain health in the digital era. These devices use electrical or magnetic stimulation to alter brain activity and have been used to treat a range of neurological and psychiatric conditions. They can also be used for non-medical purposes to enhance cognitive function, memory, and mood.

Some of the brain stimulation devices that are commonly used for improving brain health are as follows:

- Transcranial Magnetic Stimulation (TMS): TMS is a non-invasive brain stimulation technique that uses magnetic fields to stimulate nerve cells in the brain. It has been approved by the FDA for the treatment of depression and has also been used for the treatment of anxiety, chronic pain, and other conditions.
- Transcranial Direct Current Stimulation (tDCS): tDCS is a non-invasive brain stimulation technique that uses a low-level electrical current to stimulate the brain. It has been used for the treatment of depression, anxiety, and chronic pain and has also been shown to improve cognitive function and memory.
- Deep Brain Stimulation (DBS): DBS is a surgical procedure that involves implanting electrodes into specific areas of the brain to stimulate or inhibit activity. It has been used to treat a range of neurological and psychiatric conditions, including Parkinson's disease, obsessive-compulsive disorder, and depression.
- Vagus Nerve Stimulation (VNS): VNS involves implanting a device that delivers electrical impulses to the vagus nerve, which connects the brain to the rest of the body. It has been used for the treatment of epilepsy and depression and has also been used for the treatment of chronic pain and other conditions.

While brain stimulation devices have the potential to improve brain health in numerous ways, they should be used under the guidance of a trained healthcare professional. These devices can have side effects and are not appropriate for everyone. Additionally, they should be used in conjunction with other lifestyle changes such as regular exercise, healthy diet, and social connection, as these factors also play an important role in brain health. It is important to consult with a healthcare professional before incorporating brain stimulation devices into a brain health program.

2.7 Online Therapy Platforms

Online therapy platforms have become increasingly popular as a way to improve brain health in the digital era. These platforms provide individuals with access to licensed therapists and mental health professionals via the internet, making it more convenient and accessible for individuals to seek treatment for mental health conditions and improve their overall brain health. Some of the benefits of using online therapy platforms for improving brain health are as follows:

- Accessibility: Online therapy platforms make it easier for individuals to access mental health care, particularly for those who may live in remote areas or have limited mobility.
- Convenience: Online therapy sessions can be conducted from the comfort of one's own home, which can be particularly beneficial for individuals with busy schedules or those who have difficulty leaving the house.

- Privacy: Online therapy sessions offer a level of privacy and anonymity that may not be possible in traditional in-person therapy settings.
- Affordability: Online therapy platforms may be more affordable than traditional in-person therapy sessions, particularly for individuals who do not have insurance coverage for mental health care.
- Variety of services: Online therapy platforms offer a range of services, including individual therapy, group therapy, and specialized treatment programs for specific mental health conditions.

Online therapy platforms have numerous benefits, but it is important to choose a platform that is reputable and employs licensed therapists and mental health professionals. It is also important to ensure that the platform is secure and protects personal information. Additionally, online therapy may not be appropriate for everyone and may not be effective for certain mental health conditions. It is important to consult with a healthcare professional to determine if online therapy is a suitable option for improving brain health.

3 Benefits of the Digital Era on Brain Health

The digital era has brought about many benefits for brain health, particularly in terms of accessibility and convenience. However, it is important to use technology in moderation and to consult with healthcare professionals to ensure that technology is being used safely and effectively. Following are some benefits of the digital era on brain health.

3.1 Neural Exercises

The internet and digital era have provided many opportunities for neural exercise, allowing individuals to engage in activities that challenge and stimulate the brain from the comfort of their own homes. Here are some examples of neural exercises using the internet and digital tools. However, it is important to use these tools in moderation and to engage in a variety of neural exercises for optimal brain health.

- Brain training apps: There are many brain training apps available for smartphones and tablets that offer exercises and games designed to improve cognitive function, memory, and attention.
- Online learning platforms: Online learning platforms, such as Coursera and Udemy, offer a wide range of courses and tutorials that allow individuals to learn new skills and challenge their brains.
- Brain games and puzzles: Some many websites and apps offer brain games and puzzles, such as Sudoku, crossword puzzles, and memory games.

- Meditation apps: Meditation apps, such as Headspace and Calm, offer guided meditations that can improve attention and reduce stress.
- Virtual reality games: Virtual reality games offer a unique opportunity to challenge the brain in a new and immersive way, allowing individuals to improve cognitive function and memory.
- Online discussion forums: Engaging in online discussion forums can stimulate the brain and improve cognitive function by exposing individuals to new ideas and perspectives.

3.2 Access to Information

The internet and digital era have made it easier than ever to access information about brain health. Here are some ways that the internet and digital tools have improved access to information about brain health:

- Online resources: There are many online resources available that provide information about brain health, including websites, blogs, and forums. These resources offer a wealth of information on topics such as brain function, mental health, and neuroplasticity.
- Health and wellness apps: There are many health and wellness apps available that offer information and guidance on brain health. These apps may include features such as mindfulness exercises, brain training games, and sleep-tracking tools.
- Social media: Social media platforms can be used to access information about brain health, including posts from experts, research studies, and news articles. Users can follow accounts and pages that share information on brain health to stay informed on the latest news and trends.
- Online courses and webinars: Online courses and webinars offer access to information on brain health, including topics such as meditation, mindfulness, and cognitive-behavioral therapy. Many of these courses and webinars are led by experts in the field and offer a convenient way to learn about brain health from the comfort of your own home.
- Telehealth services: Telehealth services offer a convenient way to access healthcare professionals who specialize in brain health, including psychiatrists, psychologists, and neurologists. These services allow individuals to receive support and guidance on brain health from anywhere with an internet connection.

3.3 Improved Multitasking Skills

The internet and digital era have provided many opportunities for individuals to improve their multitasking skills. Here are some ways that the internet and digital tools have improved multitasking skills:

- Multiple windows and tabs: Modern web browsers allow users to open multiple windows and tabs simultaneously, enabling them to switch between different tasks quickly and easily.
- Mobile devices: Smartphones and tablets allow users to access multiple apps simultaneously, making it easier to multitask while on the go.
- Productivity apps: There are many productivity apps available that offer features such as task management, note-taking, and calendar organization. These apps can help individuals keep track of multiple tasks and stay organized.
- Collaboration tools: Collaboration tools such as Google Docs and Slack allow individuals to work together on projects in real time, enabling them to multitask and work more efficiently.
- Online learning: Online courses and tutorials allow individuals to learn new skills while multitasking. For example, someone could watch a video tutorial on how to use a new software program while also working on a different task.

Overall, the internet and digital tools have provided many opportunities for individuals to improve their multitasking skills. However, it is important to note that multitasking can also have negative effects on productivity and mental health. It is important to find a balance between multitasking and focusing on one task at a time. Additionally, it is important to prioritize tasks and set realistic goals to avoid feeling overwhelmed or burnt out.

3.4 Working Memory and Fluid Intelligence

The internet and digital era have provided many opportunities for individuals to improve their working memory and fluid intelligence. Here are some ways that the internet and digital tools have improved working memory and fluid intelligence:

- Brain training games and apps: There are many brain training games and apps available that have been designed to improve working memory and fluid intelligence. These games and apps may include tasks such as memory games, attention exercises, and problem-solving tasks.
- Online courses and tutorials: Online courses and tutorials can help individuals improve their working memory and fluid intelligence by teaching them new skills and knowledge. These courses and tutorials may include topics such as coding, language learning, and critical thinking.
- Social media and online communities: Social media and online communities can also improve working memory and fluid intelligence by providing opportunities

for social interaction, debate, and discussion. These activities can help individuals develop their critical thinking and problem-solving skills.
- Online research and information retrieval: The internet provides a vast amount of information on almost any topic, and individuals who are skilled in finding, organizing, and retaining this information are likely to have strong working memory and fluid intelligence.
- Online collaboration and teamwork: The internet has made it easier than ever to collaborate with others on projects and tasks. Working with others online can help individuals develop their teamwork skills, problem-solving abilities, and communication skills.

3.5 Visual Attention Reaction Time

The internet and digital era have also provided opportunities for individuals to improve their visual attention reaction time. Here are some ways that the internet and digital tools have improved visual attention reaction time:

- Video games: Video games can improve visual attention reaction time by requiring the player to quickly respond to visual cues on the screen. Games such as first-person shooters or racing games can improve reaction times and visual attention.
- Online sports and fitness training: Online sports and fitness training can also improve visual attention reaction time by requiring the user to react quickly to visual stimuli. Training programs such as agility drills or reaction time exercises can improve visual attention and reaction time.
- Virtual and augmented reality: Virtual and augmented reality technologies can provide immersive environments that require the user to react quickly to visual stimuli. These technologies can improve visual attention and reaction time by simulating real-world scenarios that require quick reactions.

3.6 Telemedicine

Telemedicine, which involves the use of digital technology to provide remote medical care, has the potential to improve brain health in the digital era in several ways:

- Improved access to healthcare: Telemedicine allows individuals to receive medical care and support for brain health challenges from the comfort of their homes, regardless of their location. This can improve access to care for individuals who live in remote areas or have mobility challenges that make it difficult to access traditional healthcare services.

- Increased convenience: Telemedicine offers the convenience of receiving care without the need to travel to a healthcare facility, which can be especially beneficial for individuals with busy schedules or mobility challenges.
- Enhanced monitoring and management: Telemedicine technology can be used to remotely monitor and manage brain health conditions, such as dementia or Parkinson's disease. This allows for early detection of changes in symptoms and timely adjustments to treatment plans.
- Access to specialists: Telemedicine technology can provide access to specialists in the field of brain health, even if they are located in a different city or country. This can improve the quality of care for individuals with complex brain health conditions who require specialized expertise.
- Increased patient engagement: Telemedicine can increase patient engagement in their own healthcare by providing access to digital tools that support brain health, such as cognitive training apps or online therapy platforms.

Overall, telemedicine can be a valuable tool for improving brain health in the digital era by increasing access to care, enhancing convenience, and improving patient engagement and outcomes.

4 Discussions

In this chapter, the impact of digital media on the human brain was examined. While it was discovered that digital technologies and media can have both negative and positive effects, excessive use can be harmful and potentially damage the brain. However, if used in moderation, there can be benefits as well. The increasing use of digital media in the modern era has raised concerns about its impact on the human brain. This chapter highlights that while there are some benefits associated with the use of digital media, the negative consequences of excessive use cannot be ignored. Research has shown that excessive use of digital media can lead to addiction, depression, anxiety, decreased attention span, and decreased cognitive abilities. However, it is important to note that the impact of digital media on the brain is not entirely negative. In some cases, it can have positive effects, such as improving cognitive abilities and increasing access to information. For example, digital media can be used to promote brain health through the use of cognitive training apps, online therapy platforms, and telemedicine.

In order to improve the brain health, there are certain recommendations which may be taken into consideration depending upon the age-group, as listed in Table 2.

Following are some of the technical and standard recommendations to improve brain health in the digital era:

- Use technology responsibly: To minimize the negative effects of digital technology on brain health, it is important to use it responsibly. This includes setting limits on screen time, taking regular breaks, and using tools such as blue light filters to reduce the impact of digital devices on sleep.

Table 2 Recommendations for reducing effects of digital technologies [10]

Sr. No.	Age-group	Recommendations
1	Younger than 18 months	Should avoid screen time other than video calling
2	1824 months	Spend time in other high-quality programs
3	2–5 years	1 h/day supervised high quality programming
4	6 years and above	Place consistency in limits of using media

- Follow ergonomic guidelines: To reduce physical strain and injury associated with computer use, follow ergonomic guidelines such as positioning your computer screen at eye level, using an ergonomic keyboard and mouse, and taking regular breaks to stretch and move.
- Use assistive technology: If you have a condition that affects your ability to use digital devices, such as a visual impairment or a mobility impairment, consider using assistive technology such as screen readers or voice-activated assistants.
- Follow security best practices: To protect your brain health and personal information online, follow security best practices such as using strong passwords, avoiding public Wi-Fi networks, and being cautious about clicking on links or downloading attachments from unknown sources.
- Use evidence-based digital tools: When choosing digital tools to support brain health, look for evidence-based tools that have been scientifically validated to improve brain function, such as cognitive training apps or virtual reality therapy.
- Seek professional support: If you are experiencing mental health challenges or cognitive impairment, seek professional support from a qualified healthcare provider. Online therapy platforms and telehealth services can provide access to mental health support and cognitive assessments from the comfort of your home.

By following these technical and standard recommendations, you can help improve brain health in the digital era while minimizing the negative impacts of digital technology on your well-being. To reap the benefits of the digital era while minimizing the negative consequences, it is important to use digital media in moderation. The chapter provides age group-wise recommendations to promote responsible use of digital media. For children and teenagers, it is recommended to limit screen time, prioritize physical activity and social interaction, and promote healthy sleep habits. For adults, it is recommended to limit screen time before bed, take breaks from digital media, and engage in activities that promote brain health, such as exercise, reading, and meditation.

5 Conclusions

In conclusion, the impact of digital media on brain health is complex and multifaceted. While it can have both positive and negative consequences, responsible use and moderation are key to promoting brain health in the digital era. The recommendations provided in this chapter can serve as a guide for individuals to make

informed decisions about their use of digital media and promote healthy brain function.Conflicts of InterestNo author has any potential conflicts of interest.

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